THE

PHYSIOLOGY OF DIGESTION

CONSIDERED WITH RELATION TO

THE PRINCIPLES OF DIETETICS.

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"Nor is it left *arbitrary*, at the will and pleasure of every man, to do as he *list;* after the dictates of a depraved *humour* and extravagant *phancy*, t live at what rate he pleaseth; but every one is bound to observe the *Injunctions* and *Law of Nature*, upon the penalty of forfeiting their *health*, *strength*, and *liberty*—the true and long enjoyment of themselves."

Mainwayringe.

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PREFACE.

The present volume is essentially a continuation of the work first published about two years ago, under the title of "The Principles of Physiology applied to the Preservation of Health and to the Improvement of Physical and Mental Education;" and its object is the same—namely, to lay before the public a plain and intelligible description of the structure and uses of some of the more important organs of the human body, and to show how information of this kind may be usefully applied in practical life.

In "The Principles of Physiology," the structure and functions of the skin, muscles, bones, lungs, and nervous system, the laws or conditions of their healthy action, and the unsuspected origin of many of their diseases in infringements of these laws, were explained in succession and at considerable length; and the means by which their health and efficiency might best be secured were pointed out. It was stated that, in selecting these organs as subjects for discussion, I had been guided by the desire to notice in preference those functions which are most influential in their operation on the general system, and at the same time least familiarly known; and that, if the attempt to convey the requisite information in a manner suited to the general reader should prove

successful, I would afterward prepare a similar account of others, in the right understanding and management of which our interest is not less deeply involved, but in regard to which much ignorance continues nevertheless to prevail, even among the most liberally educated classes of society.

The numerous proofs which I received of the utility of my former work, not only from professional and literary journals, but also from individuals previously unknown to me,—many of them guardians and instructers of youth, speaking from personal experience,—together with the rapid sale of three editions (the last consisting of 3000 copies) in two years, soon completely satisfied me that I had neither been deceived as to the real importance of physiological knowledge to the general public, nor been altogether unsuccessful in the method of conveying it. Thus encouraged, accordingly, I cheerfully resumed my labours, and began the preparation of the treatise now submitted to the indulgent consideration of the reader.

The matters discussed on the present occasion relate chiefly to the function of digestion and the principles of dietetics;. and in selecting them I have been guided by the same principle as before. It may, at first sight, be doubted whether I have not exceeded proper bounds in thus dedicating a whole volume to the consideration of a single subject; but the more we consider the real complication of the function of digestion,—the extensive influence which it exercises at every period of life over the whole of the bodily organization,—the degree to which its

morbid derangements undermine health, happiness, and social usefulness, and especially the share which they have in the production of scrofulous and consumptive, as well as of nervous and mental affections, —we shall become more and more convinced of the deep practical interest which attaches to a minute acquaintance with the laws by which it is regulated. In infancy, errors in diet, and derangement of the digestive organs, are admitted to be the principal causes of the striking mortality which occurs in that period of life. In youth and maturity, the same influence is recognised, not only in the numerous forms of disease directly traceable to that origin, but also in the universal practice of referring every obscure or anomalous disorder to derangement of the stomach or bowels. Hence, too, the interest which has always been felt by the public in the perusal of books on dietetics and indigestion ; and hence the prevalent custom of using purgatives as remedies for every disorder, very often with good, but not unfrequently with most injurious effects.

Numerous and popular, however, as writings on dietetics have been, and excellent as are many of the precepts which have been handed down by them from the earliest ages, sanctioned by the warm approval of every successive generation, it is singular how very trifling their influence has been, and continues to be, in altering the habits of those to whom they are addressed. In a general way, we all acknowledge that diet is a powerful agent in modifying the animal economy ; yet, from our *conduct*, it might justly be inferred, that we either regarded it as totally

devoid of influence, or remained in utter ignorance of its mode of operation, being left to the guidance of chance alone, or of notions picked up at random, often at variance with reason, and, it may be, in contradiction even with our own daily experience.

The cause of this extraordinary anomaly—and it is of consequence to remark it—seems to be, not so much the absolute want of valuable information, as the faulty manner in which the subject is usually considered. In many of our best works, *the relation subsisting between the human body on the one hand, and the qualities of the alimentary substances on the other*, as the only solid principle on which their proper adaptation to each other can be based, is altogether lost sight of; so that, while the attention is carefully directed to the consideration of the abstract qualities of the different kinds of aliment, little or no regard is paid to the relation in which they stand to the individual constitution, as modified by age, sex, season, and circumstances, or to the observance of the fundamental laws of digestion. And hence, although these conditions are not unfrequently of much greater importance to the general health than even the right selection of food, yet, when indigestion arises from neglecting them, the food alone is blamed, and erroneous conclusions are drawn, by relying on which upon future occasions, we may easily be led into still more serious mistakes.

It is, indeed, from being left in this way without any guiding principle to direct their experience, and test the accuracy of the precepts laid down to them

for the regulation of their conduct, that many persons begin by being bewildered by the numerous discrepances which they meet with between facts and doctrine—between counsel and experience, and end by becoming entirely skeptical on the subject of all dietetic rules whatever, and regarding them as mere theoretical effusions, based on fancy, and undeserving of a moment's consideration.

The true remedy for this state of things is, not to turn away in disgust and despair, but to resort to a more rational mode of inquiry—certain that, in proportion as we advance, some useful result will reward our labours. Such, accordingly, has been my aim in the present publication; and if I shall be found to have been even moderately successful in attaining it, I shall rejoice in the confident conviction that others will be led to still more positive and beneficial results. Utility, and not novelty, has been my great object throughout; and therefore, although in some instances I have perhaps regarded known facts in a new point of view, and deduced from them practical inferences of considerable value, I lay no claim to any farther originality, except such as is implied in the adoption of what I conceive to be an improved mode of investigation; and if I have anywhere used expressions which may seem either to do injustice to others, or to arrogate too much credit to myself, it has been entirely without any such design, and, consequently, I will be prompt to acknowledge my error and rectify the involuntary mistake.

In preparing the present volume for the press I have derived the utmost advantage from a very valu-

able work by Dr. Beaumont, an American writer, which, though scarcely at all known in this country, contains an authentic record of some of the most curious and instructive observations which have ever been made on the process of digestion. That excellent and enlightened physiologist had the rare good fortune to meet with a case where an artificial opening into the stomach existed, through which he could see every thing that took place during the progress of healthy digestion; and, with the most disinterested zeal and admirable perseverance, he proceeded to avail himself of the opportunity thus afforded of advancing human knowledge, by engaging the patient, at a heavy expense, to live with him for several years, and become the subject of numerous and carefully conducted experiments. Of the results thus obtained, I have not scrupled to make the freest and most ample use; both because they illustrate almost every point of importance connected with digestion, and because, from Dr. Beaumont's work being still inaccessible to the British reader, it is a bare act of justice towards him, and also the best way of fulfilling the objects he had in view, to make its contents known as widely as possible: for wherever they are known they will be acknowledged to redound to his credit, not less as a man than as a philosopher.

In the course of these pages the reader will occasionally meet with repetitions, which he may, perhaps with justice, think unnecessary. The only apology I have to offer for them is, that the intimate manner in which the different functions are connected with each other, sometimes made it impossible to explain

one without referring to the rest; and also that, my prime objects being to render the meaning unequivocally plain, and impress the subject deeply upon the reader's mind, I thought it better to risk occasional repetition of an important truth, than to leave it in danger of being vaguely apprehended, or its enunciation in any degree obscure. For these reasons, it is hoped that the fault—if such it is—will be leniently overlooked.

Those who wish to study more fully the subject of dietetics, will find much useful information in Dr. Hodgkin's "Lectures on the Means of Promoting and Preserving Health;" Professor Dunglison "On the Influence of Atmosphere and Locality, Change of Air and Climate, Seasons, Food, Clothing, Bathing, Exercise, Sleep, Corporeal and Intellectual Pursuits, &c. &c. &c. on Human Health;" Dr. Paris "On Diet;" and Dr. Kilgour's "Lectures on the Ordinary Agents of Life, as applicable to Therapeutics and Hygiène."

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PART I.

PHYSIOLOGY OF DIGESTION.

CHAPTER I.

INTRODUCTORY REMARKS.

Waste or loss of substance always attendant on action.—In the vegetable and animal kingdoms waste is greater than in the physical.—Living bodies are distinguished by possessing the power of repairing waste.—Vegetables, being rooted in one place, are always in connexion with their food.—Animals, being obliged to wander, receive their food at intervals into a stomach.—Nutrition most active when growth and waste are greatest.—In vegetables the same causes which increase these processes also stimulate nutrition.—But animals require a monitor to warn them when food is needed.—The sense of Appetite answers this purpose.—The possession of a stomach implies a sense of Appetite to regulate the supplies of food.

Throughout every department of Nature waste is the invariable result of action. Even the minutest change in the relative position of inanimate objects cannot be effected without some loss of substance. So well is this understood, that it is an important aim in mechanics to discover the best means of reducing to the lowest possible degree the waste consequent upon motion. Entirely to prevent it is admitted to be beyond the power of man; for, however nicely parts may be adjusted to each other, however hard and durable their materials, and however smoothly motion may go on, still, in the course

of time, loss of substance becomes evident, and repair and renewal become indispensable to the continuance of the action.

It is thus a recognised fact, or general law of nature, that nothing can act or move without undergoing some change, however trifling in amount. Not even a breath of wind can pass along the surface of the earth without altering in some degree the proportions of the bodies with which it comes into contact; and not a drop of rain can fall upon a stone without carrying away some portion of its substance. The smoothest and most accurately formed wheel, running along the most level and polished railroad, parts with some portion of its substance at every revolution, and in process of time is worn out and requires to be replaced. The same effect is forcibly, though rather ludicrously, exemplified in the great toe of the bronze statue of St. Peter at Rome, which, in the course of centuries, has been worn down to less than half its original size by the successive kisses of the faithful; and I venture to mention it, because it affords one of the best specimens of the operation of a principle, the existence of which, from the imperceptibly small effect of any single act, might otherwise be plausibly denied.

As regards *dead* or *inanimate* matter, the destructive influence of action is constantly forced upon our attention by every thing passing around us; and so much human ingenuity is exercised to counteract its effects, that no reflecting person will dispute the universality of its operation. But when we observe shrubs and trees waving in the wind, and animals undergoing violent exertion, for year after year, and yet both continuing to increase in size, we may be inclined, on a superficial view, to regard *living* bodies as constituting exceptions to the rule. On more careful examination, however, it will appear, that waste goes on in living bodies not only without

any intermission, but with a rapidity immeasurably beyond that which occurs in inanimate objects. In the vegetable world, for instance, every leaf of a tree is incessantly pouring out some portion of its fluids, and every flower forming its own fruit and seed, speedily to be separated from and lost to its parent stem; thus causing in a few months an extent of waste many hundred times greater than what occurs in the same lapse of time after the tree is cut down, and all its living operations are at a close. The same thing holds true in the animal kingdom. So long as life continues, a copious exhalation from the skin, the lungs, the bowels, and the kidneys, goes on without a moment's intermission; and not a movement can be performed which does not at least partially increase the velocity of the circulation, and add something to the general waste. In this way, during violent exertion, several ounces of the fluids of the body are sometimes thrown out by perspiration in a very few minutes; whereas, after life is extinguished, all the excretions cease, and waste is limited to that which results from ordinary chymical decomposition.

So far, then, the law that waste is attendant on action, applies to both dead and living bodies; but beyond this point a remarkable difference between them presents itself. In the physical or inanimate world, what is once lost or worn away is lost for ever. There is no power inherent in the piston of the steam-engine by which it can repair its own loss of particles; and consequently in the course of time it must either be laid aside as useless, or be remodelled by the hand of the workman. But *living* bodies, whether vegetable or animal, possess the distinguishing characteristic of being able to repair their own waste and add to their own substance. The possession of such a power is in fact essential to their very existence. If the sunflower, which in fine weather exhales thirty ounces of fluid between

sunrise and sunset, contained no provision within its own structure for replacing this enormous waste, it would necessarily shrivel and die within a few hours, as it actually does when plucked up by the roots; and, in like manner, if man, whose system throws out every day five or six pounds of substance by the ordinary channels of excretion, possessed no means of repairing the loss, his organization would speedily decay and perish. This very result is frequently witnessed in cases of shipwreck and other disasters, where, owing to the impossibility of obtaining food, death ensues from the body wasting away till it becomes incapable of carrying on the operations of life. In some instances this waste has even proceeded so far that three fourths of the whole weight of the body have been lost before life became extinct.

It is impossible to reflect on these facts, and others of a similar kind, without having the conviction forced upon our minds, that in every department of nature expenditure of material is inseparable from action; and that, in living bodies, waste goes on so rapidly, and by so many different channels, that life could not be maintained for any length of time without an express provision being made for compensating its occurrence.

In surveying the respective modes of existence of vegetables and of animals, with the view of ascertaining by what means this compensation is effected, the first striking difference between them which we perceive, is the fixity of position of the one, and the free locomotive power of the other. The vegetable grows, flourishes, and dies, fixed to the same spot of earth from which it sprang; and, however much external circumstances may change around it, it must remain and submit to their influence. If it be deprived of moisture and solar heat and light, it cannot go in search of them, but must remain to droop and to perish. If the earth to

which its roots are attached be removed, and a richer soil be substituted than that which its nature requires, it still has no option: it must grow up in rank and unhealthy luxuriance, in obedience to an impulse which it cannot resist. At all hours and at all seasons it is at home, and in direct communication with the soil from which its nourishment is extracted. And being thus without ceasing in contact with its food, it requires no storehouse in which to lay up provision, but receives immediately from the earth, and at every moment, all that is necessary for its sustenance.

But it is otherwise with animals. These not only enjoy the privilege of locomotion, but are compelled to use it, and often to go to a distance, in search of food and shelter. Consequently, if their vessels of nutrition were, like those of vegetables, in direct communication with external substances, hey would be torn asunder at every movement, and the animals themselves exposed either to die from starvation, or to forego the exercise of the higher functions for which their nature is adapted. But the necessity for a constant change of place being imposed upon them, a different arrangement became indispensable for their nutrition; and the method by which the Creator has remedied the inconvenience is not less admirable than simple. To enable the animal to move about and at the same time to maintain a connexion with its food, He has provided it with a receptacle or stomach, where it is able to store up a supply of materials from which sustenance may be gradually elaborated during a period of several hours, whithersoever it happens to go in the meantime. It thus carries along with it nourishment adequate to its wants; and the small nutritive vessels imbibe their food from the internal surface of the stomach and bowels, where the nutriment is stored up, just as the roots or nutritive vessels of vegetables do from the soil in which they

grow. The possession of a stomach or receptacle for food is accordingly a characteristic of the animal system as contrasted with that of vegetables; it is found even in the lowest orders of zoophites, which in other respects are so nearly allied to plants.

The sole object of nutrition being to repair waste and to admit of growth, Nature has so arranged that within certain limits it is always most vigorous when growth or waste proceeds with the greatest rapidity. Even in vegetables this relation is distinctly observable. In spring and summer, when vegetative life is most active, and when leaves, flowers, and fruit are to be formed, and growth carried on, nourishment is largely drawn from the soil, and the elaboration and circulation of the sap are proportionally vigorous; whereas in winter, when the leaves and flowers have passed away, and vegetable life is in repose, little nourishment is needed, and the circulation of the sap is proportionally slow. In accordance with these facts, every one will recollect how freely a shrub or a tree bleeds, as it is called, when its bark is cut early in the season, and how dry it becomes on the approach of winter. It is the activity of the circulation in summer which renders its temporary suspension by transplanting so generally fatal at that season; whereas, owing to the comparative sluggishness with which it is carried on in winter, its partial interruption is then attended with much less risk.

In vegetables, the quantity of nourishment taken entirely depends on, and is regulated by, the circumstances in which they are placed. When they are exposed, as in spring and summer, to the stimulus of heat and light, all their functions are excited, waste and growth are accelerated, and a more abundant supply of nourishment becomes indispensable to their health and existence; and hence, in a dry soil incapable of affording a copious supply of sap, they speedily wither and die. Exposed to cold, on

the other hand, and shaded from the light, their vitality is impaired, and the demand for nourishment greatly diminished. This is uniformly the case in winter; and many circumstances show that the change is really owing to the causes mentioned above, and not to any thing inherent in the constitution of the vegetable itself. In tropical climates, for example, where heat, light, and moisture abound, vegetable life is ever active, and the foliage ever thick and abundant; and even in our own northern region, we are able by artificial heat so far to anticipate the natural order of the seasons, as to obtain the ripened fruit of the vine in the very beginning of spring. The whole system of *forcing* vegetables and fruit, now so generally resorted to for the early supply of our markets, is, in truth, founded on the principle we are now discussing; and by the regulated application of heat, light, and moisture, we are able to hasten or to retard, to a very considerable extent, the ordinary stages of vegetable life. But to ensure success in our operations, we must be careful to proportion the supply of nourishment to the state of the plant at the time. If, by the application of heat, we have stimulated it to premature growth and foliage, we must at the same time provide for it an adequate supply of food, otherwise its activity will exhaust itself, and induce premature decay. Hence the regular watering which greenhouse plants require. But if we have retarded its progress and lowered its vitality by excluding heat and light, the same copious nourishment will not only be unnecessary, but will probably do harm by inducing repletion and disease.

In vegetables, the absorption of food is thus regulated entirely by the circumstances of heat, moisture, and light, under which the plant is placed, and by the consequent necessity which exists at the time for a larger or smaller supply of nourishment to carry on the various processes of vegetable life.

According to this arrangement, nutrition is always most active when the greatest expenditure of material is taking place. When growth is going on rapidly, and the leaves are unfolding themselves, sap is sucked up from the earth in great quantity; but when these processes are completed as summer advances, and almost no fresh materials are required, except for the consolidation of the new growth and the supply of the loss by exhalation, a much smaller amount of nourishment suffices, and the sap no longer circulates in the same profusion. In autumn, again—when the fruit arrives at maturity, the leaves begin to drop off, and the activity of vegetable life suffers abatement,—nutrition is reduced to its lowest ebb; and in this state it continues till the return of spring stimulates every organ to new action, and once more excites a demand for an increased supply.

Nor is the same great principle, of supply requiring to be proportioned to demand, less strikingly apparent in animals. Wherever growth is proceeding rapidly, or the animal is undergoing much exertion and expenditure of material, an increased quantity of food is invariably required; and, on the other hand, where no new substance is forming, and where, from bodily inactivity, little loss is sustained, a comparatively small supply will suffice. But as animals are subjected to much more rapid and violent transitions from activity to inactivity than vegetables are—and thus require to pass more immediately from one kind and quantity of nourishment to another, in order to adapt their nutrition to the ever-varying demands made upon the system—they evidently stand in need of some provision to enforce attention when nourishment is necessary, and to enable them always to proportion the supply to the real wants of the body. Not being, like vegetables, in constant connexion with their aliment, they might suffer from neglect if they did not possess some contrivance to warn them in time when

to seek and in what quantity to consume it: But in endowing animals with the sense of *Appetite*, or the sensations of *Hunger* and *Thirst* generally included under it, the Creator has guarded effectually against the inconvenience, and given to animals a guide in every way sufficient for the purpose.

The very possession of a stomach or receptacle, into which food sufficient for several hours can be introduced at one time, and which we have already remarked as characterizing all animals from the lowest to the highest, almost necessarily implies the coexistence of some watchful monitor, such as appetite, to enforce attention to the wants of the system, with an earnestness which it shall not be easy to resist. If this were not the case in man, for example—if he had no motive more imperative than reason to oblige him to take food—he would be constantly liable, from indolence and thoughtlessness, or the pressure of other occupations, to incur the penalty of starvation, without being previously aware of his danger. But the Creator, with that beneficence which distinguishes all his works, has not only provided an effectual safeguard in the sensations of hunger and thirst, but, moreover, attached to their regulated indulgence a degree of pleasure which never fails to ensure attention to their demands, and which, in highly civilized communities, is apt to lead to excessive gratification. Such being the important charge committed to the appetites of hunger and thirst, it will be proper to submit to the reader, before entering upon the consideration of the more complicated process of digestion, a few remarks on their nature and use.

CHAPTER II.

THE APPETITES OF HUNGER AND THIRST.

Hunger and Thirst, what they are.—Generally referred to the stomach and throat, but perceived by the brain.—Proofs and illustrations.—Exciting causes of hunger.—Common theories unsatisfactory.—Hunger sympathetic of the state of the body as well as of the stomach.—Uses of appetite.—Relation between waste and appetite.—Its practical importance.—Consequences of overlooking it illustrated by analogy of the whole animal kingdom.—Disease from acting in opposition to this relation.—Effect of exercise on appetite explained.—Diseased appetite.—Thirst.—Seat of Thirst.—Circumstances in which it is most felt.—Extraordinary effects of injection of water into the veins in cholera.—Uses of thirst, and rules for gratifying it.

In the preceding chapter we have endeavoured to show, *first*, that nutrition is required only because waste, and a deposition of new particles, are continually going on, so that the body would speedily become exhausted if its constituent materials were not renewed; *secondly*, that the sense of appetite is given to animals for the express purpose of warning them when a fresh supply of aliment is needed —as, without some such monitor, they would be apt to neglect the demands of nature; and, *thirdly*, that vegetables have no corresponding sensation, simply because, from their being at all times in communication with the soil, their nutrition goes on continuously in proportion as it is necessary, and without requiring any prompter to put it in action at particular times.

If these principles be correct, it follows that, in the healthy state (and let the reader be once for all made aware that in the following pages the state of health is always implied, except where it is oth-

erwise plainly expressed), the dictates of appetite will not be every day the same, but will vary according to the mode of life and wants of the system, and, when fairly consulted, will be sufficient to direct us both at what time and in what quantity we ought to take in either solid or liquid sustenance. But, to make this perfectly evident, a few general observations may be required.

It is needless to waste words in attempting to describe what hunger and thirst are: every one has felt them, and no one could understand them without such experience, any more than sweetness or sourness could be understood without tasting sweet or sour objects. Their end is manifestly to proclaim that farther nourishment is required for the support of the system; and our first business is therefore to explain their nature and seat, in so far at least as a knowledge of these may be conducive to our welfare.

The sensation of hunger is commonly referred to the stomach, and that of thirst to the upper part of the throat and back of the mouth; and correctly enough to this extent, that a certain condition of the stomach and throat tends to produce them. But, in reality, the sensations themselves, like all other mental affections and emotions, have their seat in the brain, to which a sense of the condition of the stomach is conveyed through the medium of the nerves. In this respect, Appetite resembles the senses of Seeing, Hearing, and Feeling; and no greater difficulty attends the explanation of the one than of the others. Thus, the cause which excites the sensation of colour, is certain rays of light striking upon the nerve of the eye; and the cause which excites the perception of sound, is the atmospherical vibrations striking upon the nerve of the ear; but the sensations themselves take place in the brain, to which, as the organ of the mind, the respective impressions are conveyed. In like man-

ner, the cause which excites appetite is an impression made on the nerves of the stomach; but the feeling itself is experienced in the brain, to which that impression is conveyed. Accordingly, just as in health no sound is ever heard except when the external vibrating atmosphere has actually impressed the ear, and no colour is perceived unless an object be presented to the eye,—so is appetite never felt, except where, from want of food, the stomach is in that state which forms the proper stimulus to its nerves, and where the communication between it and the brain is left free and unobstructed.

But as, in certain morbid states of the brain and nerves, voices and sounds are heard, or colours and objects are seen, when no external cause is present to act upon the ear or the eye,—so, in disease, a craving is often felt when no real want of food exists, and where, consequently, indulgence in eating can be productive of nothing but mischief. Such an aberration is common in nervous and mental diseases, and not unfrequently adds greatly to their severity and obstinacy. In indolent unemployed persons, who spend their days in meditating on their own feelings, this craving is very common, and from being regarded and indulged as if it were healthy appetite, is productive of many dyspeptic affections.*

If the correctness of the preceding explanation of the sensation of hunger be thought to stand in need of confirmation, I would refer to the very conclusive experiments by Brachet of Lyons, as setting the question entirely at rest. Brachet starved a dog for twenty-four hours, till it became ravenously hungry, after which he divided the nerves which convey to the brain a sense of the condition of the stomach. He then placed food within its reach,

* Dyspepsy (from the Greek words δυς, *dys*, bad, and πεπτω, *pepto*, I concoct) is synonymous with indigestion.

but the animal, which a moment before was impatient to be fed, went and lay quietly down, as if hunger had never been experienced. When meat was brought close to it, it began to eat; and, apparently from having no longer any consciousness of the state of its stomach—whether it was full or empty—it continued to eat till both it and the gullet were inordinately distended. In this, however, the dog was evidently impelled solely by the *gratification of the sense of taste*; for on removing the food at the beginning of the experiment to the distance of even a few inches, it looked on with indifference, and made no attempt either to follow the dish or to prevent its removal.*

Precisely similar results ensued when the nervous communication between the stomach and brain was arrested by the administration of narcotics. A dog suffering from hunger turned listlessly from its food when a few grains of opium were introduced into its stomach. It may be said that such a result is owing to the drug being absorbed and carried to the brain through the ordinary medium of the circulation; but Brachet has proved that this is not the case, and that the influence is primarily exerted upon the nerves. To establish this point, two dogs of the same size were selected. In one the nerves of communication were left untouched, and in the other they were divided. Six grains of opium were then given to each at the same moment. The sound dog began *immediately* to feel the effects of the opium, and became stupid, while the other continued lying at the fireside for a long time, without any unusual appearance except a little difficulty of breathing. In like manner, when the experiment was repeated with that powerful poison *nux vomica*, upon two dogs similarly circumstanced, the sound

* Brachet, Recherches Experimentales sur les Fonctions du Système Nerveux Ganglionaire, chap. iii. Paris edition.

one fell *instantly* into convulsions, while the other continued for a long time as if nothing had happened.

These results demonstrate, beyond the possibility of doubt, the necessity of a free nervous communication between the stomach and brain, for enabling us to experience the sensation of hunger. The connexion between the two organs is, indeed, more widely recognised in practice than it is in theory; for it is a very common custom with the Turks to use opium for abating the pangs of hunger when food is not to be had, and sailors habitually use tobacco for the same purpose. Both substances act exclusively on the nervous system.

The relation thus shown to subsist between the stomach and the brain, enables us, in some measure, to understand the influence which mental emotion and earnest intellectual occupation exert over the appetite. A man in perfect health, sitting down to table with an excellent appetite, receives a letter announcing an unexpected calamity, and instantly turns away with loathing from the food which, a moment before, he was prepared to eat with relish; while another, who, under the fear of some misfortune, comes to table indifferent about food, will eat with great zest on his "mind being relieved," as the phrase goes, by the receipt of pleasing intelligence. In such cases, no one will imagine that the calamity destroys appetite otherwise than through the medium of the brain. Sometimes the feeling of loathing and disgust is so intense, as not only to destroy appetite, but to induce sickness and vomiting,—a result which depends so closely on the state of the brain, that it is often induced even by mechanical injuries of that organ.

The analogy between the external senses and the appetite is, in various respects, very close. If we are rapt in study, or intent on any scheme, we become insensible to impressions made on the ear or

eye. A clock may strike, or a person enter the room, without our being aware of either event. The same is the case with appetite. If the mind is deeply engaged, the suggestions of appetite are unperceived and unattended to—as was well exemplified in the instance of Sir Isaac Newton, who, from seeing the bones of a chicken lying before him, fancied that he had already dined, whereas, in reality, he had eaten nothing for many hours. Herodotus ascribes so much efficacy to mental occupation in deadening the sense of hunger, that he speaks of the inhabitants of Lydia having successfully had recourse to gaming as a partial substitute for food, during a famine of many years' continuance. In this account there is, of course, gross exaggeration; but it illustrates sufficiently well the principle under discussion.

Many attempts have been made to determine what the peculiar condition of the stomach is which excites in the mind the sensation of hunger; but little success has hitherto attended them. For a long time it was imagined that the presence of *gastric* or *stomach* juice, irritating the nerves of the mucous membrane, was the exciting cause; but it was at last ascertained, that, after the digestion of a meal is completed, and the chyme has passed into the intestine, the gastric juice ceases to be secreted till *after* a fresh supply of food has been taken in.* It was next supposed that the mere emptiness of the stomach was sufficient to excite hunger, and

* It is difficult, as in the above sentence, to avoid occasionally using expressions, and referring to processes, which have not previously been explained; but it would only lead to confusion and unnecessary repetition to stop at every page and introduce explanations, which, after all, the reader would scarcely understand on account of their brevity. In the present instance, therefore, when I allude to the process of digestion, it is better to refer the reader to the outline given at the beginning of Chapter IV., than to distract his attention by introducing it also here.

that the sensation arose partly from the opposite sides rubbing against each other. But this theory is equally untenable; for the stomach generally contains a sufficient quantity of air to prevent the actual contact of its sides, and moreover it may be entirely void of food, and yet no appetite be felt. It may be laid down, indeed, as a general rule, that an interval of rest must follow the termination of digestion before the stomach becomes fit to resume its functions, or appetite is experienced in any degree of intensity; and the length of time required for this purpose varies very much, according to the mode of life and to the extent of waste going on in the system. In many diseases, too, the stomach remains empty for days in succession, without any corresponding excitation of hunger. Even in healthy sedentary people, whose expenditure of bodily substance is small, real appetite is not felt till long after the stomach is empty, and hence, one of their most common complaints is the want of appetite.

Dr. Beaumont suggests a distended state of the vessels which secrete the gastric juice as the exciting cause of hunger, and thinks that this view is strengthened by the rapidity with which the juice is poured out after a short fast—a rapidity, he says, which cannot be accounted for except by supposing the juice to have existed, ready made, in the vessels or follicles by which it is secreted. But something more is required to render any of these explanations satisfactory; because there is an obvious relation between appetite and the wants of the system, which none of them take sufficiently into account, and which is nevertheless too important to be overlooked.

If the body be very actively exercised, and a good deal of waste be effected by perspiration and exhalation from the lungs, the appetite becomes keener, and more urgent for immediate gratification; and if it is indulged, we eat with a relish unknown

on other occasions, and afterward experience a sensation of *bien-être* or internal comfort pervading the frame, as if every individual part of the body were imbued with a feeling of contentment and satisfaction, the very opposite of the restless discomfort and depression which come upon us, and extend over the whole system, when appetite is disappointed. There is, in short, an obvious and active sympathy between the condition and bearing of the stomach and those of every part of the animal frame —in virtue of which, hunger is felt very keenly when the general system stands in urgent need of repair, and very moderately when no waste has been suffered. This principle is strikingly illustrated during recovery from a severe illness. "In convalescence from an acute disease," as is well remarked by Brachet, "the stomach digests vigorously, and yet the individual is always hungry. This happens because all the wasted organs and tissues demand the means of repair, and demand them from the stomach, which has the charge of sending them; and, therefore, they keep up in it the continual sensation of want, which, however, is in this case only sympathetic of the state of the body."* No testimony can be stronger than this.

The effects of exercise, also, show this connexion very clearly. If we merely saunter out for a given time every day, without being actively enough engaged to quicken the circulation and induce increased exhalation from the skin and lungs, we come in with scarcely any change of feeling or condition; whereas, if we exert ourselves sufficiently to give a general impetus to the circulation, and bring out moderate perspiration, but without inducing fatigue, we feel a lightness and energy of a very pleasurable description, and generally accompanied by a strong

* Brachet, Recherches Experimentales sur les Fonctions du Système Nerveux Ganglionaire, p. 181.

desire for food. Hence the keen relish with which the fox-hunter sits down to table after a successful chase.

This intimate communion between the state of the system and that of the stomach is a beautiful provision of nature, and is one of the causes of the ready sympathy which has often been remarked as existing between the stomach and all the other organs—in other words, of the readiness with which they accompany it in its departure from health, and the corresponding aptitude of *their* disorders to produce derangement of the digestive function. Apparently for the purpose, among others, of thus intimately connecting the stomach with the rest of the system, it is supplied with a profusion of nervous filaments of every kind, which form a closely-interwoven nervous network in its immediate neighbourhood, and the abundance of which accounts for the severe and often suddenly fatal result of a heavy blow on the pit of the stomach.

Without pretending to determine what the precise condition of the nerves of the stomach is, which, when conveyed to the brain, excites the sensation of appetite, I think it sufficient for every practical purpose if we keep in mind that *the co-operation of the nervous system is necessary for the production of appetite*, and that *there is a direct sympathy between the stomach and the rest of the body*, by means of which the stimulus of hunger becomes unusually urgent where the bodily waste has been great, although a comparatively short time has elapsed since the preceding meal.

Appetite, then, being given for the express purpose of warning us when a supply of food is necessary, it follows that its call will be experienced in the highest intensity when waste and growth—or, in other words, the operations which demand supplies of fresh materials—are most active; and in the lowest intensity when, from indolence and the

cessation of growth, the demand is least. In youth, accordingly, when bodily activity is very great, and a liberal supply of nourishment is required both to repair waste and to carry on growth, the appetite is keener and less discriminating than at any other period of life, and, what is worthy of remark, as another admirable instance of adaptation, *digestion is proportionally vigorous and rapid:* whereas, in mature age, when growth is finished, and the mode of life more sedentary, the same abundance of aliment is no longer needed, the appetite becomes less keen and more select in its choice, and digestion loses something of the resistless power which generally distinguishes it in early youth. Articles of food which were once digested with ease are now burdensome to the stomach, and, if not altogether rejected, are disposed of with a degree of labour and difficulty that was formerly unknown.

When, however, the mode of life in mature age is active and laborious, and the waste matter thrown out of the system is consequently considerable, the appetite for food and the power of digesting it are correspondingly strong; for in general it is only when the mode of life is indolent and inactive, and the waste consequently small, that the appetite and digestion are weak. So natural, indeed, is the connexion between the two conditions, that *exercise* is proverbially the first thing we think of recommending to improve the appetite and the tone of the digestive organs, when these are observed to be impaired; and where positive disease does not exist, no other remedy is half so effectual.

It is highly important to notice this natural relation between waste and appetite, and between appetite and digestion; because, if it be real, appetite must be the safest guide we can follow in determining when and how much we ought to eat. It is true that, amid the factitious calls and wants of civilized life, its suggestions are often perverted,

and that hence we may err in blindly following every thing which assumes its semblance. The conclusion to be drawn from this, however, is not that the sense of hunger will, if trusted to, generally mislead us, but only that we must learn to distinguish its true dictates before we can implicitly rely on its guidance. If, when *fairly* consulted, its dictates are found to be erroneous, it will constitute the only known instance where the Creator has failed in the attempt to fulfil his own design—an assumption not only repugnant alike to feeling and to reason, but in fact altogether gratuitous. For the apparent discrepances which occasionally present themselves between the wants of the system and the dictates of appetite, are easily explicable on the more solid ground of our own ignorance and inattention.

Many practical errors arise from overlooking the relation which nutrition ought to bear to waste and growth. Thus, it is no uncommon thing for young men who have experienced all the pleasures of a keen appetite and easy digestion when growing rapidly or leading an active life, to induce severe and protracted indigestion, by continuing, from mere habit, to eat an equal quantity of food either when growth is finished and the system no longer requires the same extensive supply, or after a complete change from active to sedentary habits has greatly diminished that waste which alone renders food necessary. This is, in fact, one of the chief sources of the troublesome dyspeptic complaints often met with among the youthful inhabitants of our larger cities and colleges.

The error, however, is unhappily not confined to the young, but extends generally to all whose pursuits are of a sedentary nature. There are numerous persons, especially in towns and among females, who, having their time and employments entirely at their own disposal, carefully avoid every

thing which requires an effort of mind or body, and pass their lives in a state of inaction entirely incompatible with the healthy performance of the various animal functions. Having no bodily exertion to excite waste, promote circulation, or stimulate nutrition, they experience little keenness of appetite, have weak powers of digestion, and require but a limited supply of food. If, while inactive and expending little, such persons could be contented to follow nature so far as not to provoke appetite by stimulants and cookery, and to eat and drink only in proportion to the wants of the system, they would fare comparatively well. But having no imperative occupation, and no enjoyment from active and useful exertion, their time hangs heavily on their hands, and they are apt to have recourse to eating as the only avenue to pleasure still open to them; and, forgetful or ignorant of the relation subsisting between waste and nutrition, they endeavour to renew, in the present indulgence of appetite, the real enjoyment which its *legitimate* gratification afforded under different circumstances. Pursuing the pleasures of the table with the same ardour as before, they eat and drink freely and abundantly, and, instead of trying to acquire a healthy desire for food and increased powers of digestion by exercise, they resort to tonics, spices, wine, and other stimuli, which certainly excite for the moment, but eventually aggravate the mischief by obscuring its progress and extent. The natural result of this mode of proceeding is, that the stomach becomes oppressed by excess of exertion—healthy appetite gives way, and morbid craving takes its place—sickness, headache, and bilious attacks become frequent—the bowels are habitually disordered, the feet cold, and the circulation irregular—and a state of bodily weakness and mental irritability is induced, which constitutes a heavy penalty for the previous indulgence. So far, however, is the true cause of all

these phenomena from being perceived even then, that a cure is sought, not in a better regulated diet and regimen, but from bitters to strengthen the stomach, laxatives to carry off the redundant materials from the system, wine to overcome the sense of sinking, and heavy lunches to satisfy the morbid craving which they only silence for a little. Some, of course, suffer in a greater, and others in a less degree, according to peculiarities of constitution, mode of life, and extent of indulgence; but daily experience will testify, that, in its main features, the foregoing description is not overcharged, and that victims to such dietetic errors are to be met with in every class of society.

The fact of nature having meant the inactive and indolent to eat and drink less than the busy and laborious, is established not only by the diminished appetite and impaired digestion of human beings who lead a sedentary life, as contrasted with the keen relish and rapid digestion usually attendant on active exertion in the open air, but on a yet broader scale by the analogy of all other animals. In noticing this relation, Dr. Roget remarks, that "the greater the energy with which the more peculiarly animal functions of sensation and muscular action are exercised, the greater must be the demand for nourishment, in order to supply the expenditure of vital force created by these exertions. Compared with the torpid and sluggish reptile, the active and vivacious bird or quadruped requires and consumes a much larger quantity of nutriment. The tortoise, the turtle, the toad, the frog, and the chameleon, will indeed live for months without taking any food."—"The rapidity of development," he continues, "has also great influence on the quantity of food which an animal requires. Thus, the caterpillar, which grows very quickly, and must repeatedly throw off its integuments during its continuance in the larva state, consumes a vast quantity of food

compared with the size of its body; and hence we find it provided with a digestive apparatus of considerable size."*

In thus insisting on regular bodily and mental activity as indispensable to the enjoyment of a good appetite and sound digestion, the attentive reader will not, I trust, be disposed to accuse me of inconsistency because, when treating of muscular exercise in the former volume,† I explained the bad effects, and inculcated the impropriety, of indulging in any considerable exertion *immediately before or after a full meal.* It is true, as there mentioned, that exercise, either in excess or at an improper time, impairs the tone of the stomach; but it is not on that account the less true that bodily exertion, when seasonably and properly practised, is the best promoter of appetite and digestion which we possess; and it is only under the latter conditions that I now speak of it as beneficial, and even indispensable to health.

In a work like the present, it is obviously impossible to fence round every general proposition with the numerous limitations which an unusual combination of circumstances, or a departure from the state of health, might demand. And, even if possible, it would not be necessary, as the laws of exercise have been so fully explained in the volume alluded to, that their rediscussion here would unavoidably involve much repetition from its pages. At the same time, some warning remark may be required to prevent any risk of misconception, as it might otherwise be plausibly argued, for example, that there can be no such relation as I have alleged between waste and appetite, because a European, perspiring under a tropical sun, incurs great waste,

* Roget's Bridgewater Treatise on Animal and Vegetable Physiology, vol. ii., p. 112.

† Principles of Physiology, &c., chapters IV. and V.

and yet loses both appetite and digestive power. To render this a valid exception, it must be shown that the European is intended by nature to live in a tropical climate; because, if he is not, his condition under such an influence must necessarily be more or less closely allied to the state of disease, and therefore beyond the sphere to which alone my remarks are meant to apply. But even in that instance there is less contradiction than might be supposed, for the waste of the system being chiefly fluid, excites—not appetite, but its kindred sensation—thirst, to repair the loss by an unusual demand for refreshing liquids.

So true is it that the Creator has established a relation between action and nutrition, that when we attempt for any length of time to combine a full and nutritious diet with systematic inactivity, the derangement of health which generally ensues gives ample proof of the futility of struggling against his laws. Individuals, indeed, may be met with, who, from some peculiarity of constitution, suffer less than the generality of mankind from making the experiment; but even those among them who escape best, generally owe their safety to the constant use of medicine, or to a natural excess in some of the excretory functions, such as perspiration or the urinary or alvine discharges, by means of which the system is relieved much in the same way as by active exercise. In others, again, the day of reckoning is merely delayed, and there is habitually present a state of repletion, which clogs the bodily functions, and may lead to sudden death by some acute disease, when the individual is apparently in the highest health. I am acquainted with several individuals of this description, who, in the absence of all bodily exercise, are accustomed to live very fully,—to eat in the morning a hearty breakfast, with eggs, fish, or flesh,—a good solid luncheon, with wine or malt liquor, in the forenoon,—a most

substantial dinner, with dessert and several glasses of wine, and afterward tea and wine and water, in the evening,—and who nevertheless enjoy tolerably good digestion. But this advantage is gained at the expense of a very full habit of body, and a liability to frequent and profuse perspirations, and to severe attacks of bowel complaint, endangering life; so that even they cannot by any means be regarded as real exceptions to the general rule.

It is, then, no idle whim of the physician to insist on active exercise as the best promoter of appetite and digestion. Exercise is, in fact, the condition without which exhalation and excretion cannot go on sufficiently fast to clear the system of materials previously taken in; and where no waste is incurred, no need of a fresh supply, and consequently, in a healthy state of the system, no natural appetite, can exist. It is therefore not less unreasonable than vain for any one to insist on possessing, at the same time, the incompatible enjoyments of luxurious indolence and a vigorous appetite, sound digestion of a hearty meal, and general health of body; and no one who is aware of the relation subsisting between waste and appetite can fail to perceive the fact, and to wonder at the contrary notion having ever been entertained.

Among the operative part of the community we meet with innumerable examples of an opposite condition of the system, where, from excess of labour, a greater expenditure of energy and substance takes place than what their deficient diet is able to repair. It is true that the disproportion is generally not sufficient to cause that immediate wasting which accompanies actual starvation, but its effects are nevertheless very palpably manifest in the depressed buoyancy, early old age, and shorter lives of the labouring classes. Few, indeed, of those who are habitually subjected to considerable

and continued exertion survive their forty-fifth or fiftieth year. Exhausted at length by the constant recurrence of their daily task and imperfect nourishment, they die of premature decay long before attaining the natural limit of human existence.

In those states of the system, again, such as fever, during the continuance of which most of the secretions are vitiated, and the stomach itself is weakened, and where food would consequently be hurtful rather than advantageous, appetite is scarcely felt, and loathing often occupies its place. But the moment that, by the diminution of the disease, the secretions and exhalations begin to return to their healthy state, and nutrition is resumed, appetite begins to be again felt, and by-and-by becomes abundantly vigorous, in order to restore the system to its former state. The utmost caution, however, is still required in its gratification, as a premature indulgence is almost certain again to stop the secretions and to produce a relapse. Ignorance of this principle among the community at large, and the consequent error of giving food when there is no demand for it, often do more to defeat the best laid plan of cure than the severity of the disease itself. The sick man's friends, in their anxiety to support his strength, too frequently turn a deaf ear to every caution which is suggested, and stealthily administer sustenance when the system does not require it, and when it serves only to aggravate the danger and increase the weakness of the patient.

Appetite, it ought to be observed, may, like other sensations, be educated or trained to considerable deviations from the ordinary standard of quantity and quality—and this obviously for the purpose of enabling man to live in different climates and under different circumstances, and avoid being fixed down to one spot and to one occupation. In civilized life, however, we are accustomed to take undue advantage of this capability, by training the appetite

to desire a greater quantity of food than what the wants of the system require, and stimulating its cravings by a system of cookery little in harmony with the intentions of nature. But this is evidently an abuse, and no argument whatever against the sufficiency of its *natural* indications to lead us right.

The most common source, however, of the errors into which we are apt to fall in taking appetite as our only guide, is unquestionably the *confounding of appetite with taste*, and continuing to eat for the gratification of the latter long after the former is satisfied. In fact, the whole science of a skilful cook is expended in producing this *willing* mistake on our part; and he is considered decidedly the best *artiste* whose dishes shall recommend themselves most irresistibly to the callous palate of the gourmand, and excite on it such a sensation as shall at least remind him of the enviable excellence of a natural appetite. If we were willing to limit the office of taste to its proper sphere, and to cease eating when appetite expressed content, indigestion would be a much rarer occurrence in civilized communities than it is observed to be.

Viewed, then, in its proper light, appetite is to be regarded as kindly implanted in our nature for the express end of proportioning the supply of nourishment to the wants of the system; and if ever it misleads us, the fault is not in its unfitness for its object, but in the artificial training which it receives at our own hands. When we attend to its real dictates, we eat moderately, and at such intervals of time as the previous exercise and other circumstances render necessary; and in so doing, we reap a reward in the daily enjoyment of the pleasure which attends the gratification of healthy appetite. But if we err, either by neglecting the timely warning which it gives, or by eating more than the system requires, mischief is sure to follow. In the former case, waste continues to make progress till the

body becomes exhausted; and in almost exact proportion do the cravings of appetite become more and more intense, till they pass into those of uncontrollable *hunger*, which overthrows all obstacles, and seeks gratification at the risk of life itself. In the latter case, indigestion, gloomy depression, and repletion, with its concomitant evils, make their appearance, and either imbitter or cut short existence.

Mischief sometimes arises also from people not being sufficiently aware, that, in common with other sensations, appetite may be so far deranged by disease as to give very incorrect and unnatural indications. It often happens, for example, that a patient shivers and complains of cold, when we know by the thermometer that the heat of the skin is really above instead of below the natural standard. In like manner, in some morbid states of the nervous system, a craving is often felt which impels the patient to eat, but which is not true hunger; and here food, if taken, is digested with great difficulty. Occasionally, on the other hand, no desire for food is experienced when the system really needs it, and when it would be digested with ease if introduced into the stomach. Esquirol alludes to cases of this description, and I have met with similar examples. Voisin also mentions, that, in the Hospital of Incurables in Paris, there are some idiots so low in the scale of intelligence as to make no attempt to take the food which is placed before them, although they eat and digest readily when fed by others. Sometimes, again, appetite is depraved in quality, and the patient desiderates the most nauseous and repulsive kinds of food, such as earth, chalk, coals, and excrement. There are states, too, in which the appetite is prodigiously increased, and the patient consumes incredible quantities of food,—which, however, are very imperfectly digested. Charles Domery, for instance, when a French

prisoner at Liverpool, consumed, in one day, four pounds of cow's udder and ten pounds of raw beef, with two pounds of tallow candles and five bottles of porter; and, although allowed the daily rations of ten men, he was still not satisfied. Baron Percy speaks of another man, who ate twenty-four pounds of beef in as many hours, and thought nothing of swallowing a dinner prepared for fifteen German boors. I once attended a patient who was afflicted with a similar inordinate craving, and whose only pleasure was in eating. In such cases no restraint except actual coercion is sufficient to prevent indulgence; but the craving itself is as much the product of disease as the shivering in the beginning of fever, and can no more be removed by reasoning than the sensation of cold can be removed by telling a patient that his skin is thermometrically warm. But these, being cases of disease, do not in any degree militate against the accuracy of the exposition above given of the healthy uses of appetite.

The general considerations which I have just submitted to the reader on the subject of appetite for food, apply so closely to the sensation of *Thirst*, that to enter into any detail concerning the latter would be little else but to be guilty of repetition. I shall therefore limit myself to a very few remarks.

Thirst is generally said to have its seat in the back of the mouth and throat; but the condition of these parts is merely a local accompaniment of a want experienced by the whole frame, and perceived by the nervous system. Local applications, accordingly, go but a short way in giving relief, while the introduction of fluids by any other channel—by immersion in a bath, by injection into the veins, or through an external opening into the stomach—is sufficient to quench thirst without the liquid ever touching the throat. The affection of that

part, therefore, is merely a result of the state of the system, and not itself the cause of thirst.

Thirst, or a desire for liquids, is experienced in its greatest intensity when the secretion and exhalation of the animal fluids is most active; and it is consequently most urgent in summer, in warm climates, and in persons engaged in severe exertion, particularly if exposed at the same time to a heated atmosphere. Blacksmiths, glassblowers, engineers, and others, whose employment exposes them to the heat of furnaces, and in whom perspiration is excessive, are accordingly almost constantly under the influence of thirst; whereas those who are employed in professions requiring only moderate exertion in a temperate atmosphere, and in whom the fluid secretions are very moderate, rarely experience the sensation in an urgent degree.

Thirst varies in intensity also according to the nature of the food. If the diet be hot and stimulating, such as results from a free admixture of spices or salt, the desire for drink is greatly increased. The same thing happens if the food be of a dry and solid nature. The purpose of the increased thirst in the former circumstance, is manifestly to dilute and diminish the excess of stimulant, and thereby prevent the injury which it would otherwise inflict. The same principle explains the thirst experienced by those who drink too much wine. In instances of this kind, I have heard great thirst in the evening and during the night complained of as habitual, without the person even suspecting that it was owing to the wine; and yet, on abstaining from the latter, the thirst very soon disappeared.

Continued thirst, it is well known, is much more intolerable than continued hunger. The mass of circulating fluid in the body is very great, and, as the various excretions consist chiefly of fluid matter, it necessarily happens, that when these have been eliminated for a considerable time without any

liquid being received into the system, the proportion of solid matter in the body becomes unduly large. The blood, consequently, becomes thicker, and changed in quality, and much more irritating than it is in its natural state. The craving of thirst is thus generally rendered more urgent and overpowering than that of hunger.

In Asiatic Cholera, the watery portion of the blood, on which its fluidity depends, is drained off with frightful rapidity; and the result is, in the first place, an almost complete stoppage of the circulation, and, in the second, a constant craving for drink to supply the place of the lost serum, which consists chiefly of water, holding some of the alkaline salts in solution. This circumstance explains, in some degree, the extraordinary effects which have been produced, even in the worst stages of the disease, when life seemed almost extinct, by injecting large quantities of saline solutions into the veins. Patients apparently on the verge of existence, cold, pulseless, and inanimate, have, in the course of a few minutes, been enabled by this means to sit up in bed, and to exhibit all the signs of restored strength and health. The effect, it is true, was rarely permanent, but for the time it was so wonderful as often to look like restoration from the dead.

Fluids taken into the stomach, it is proper to observe, are not subjected to the slow process of digestion, but are absorbed *directly* into the system; so that, when we take a moderate draught, the whole of it is taken up from the stomach in a very few minutes. Keeping in view this fact, and the above striking illustration of the influence of the condition of the blood upon the body at large, it becomes easy to conceive why, in a state of exhaustion from abstinence, drink should be more speedily restorative and refreshing than food.

Thirst, like appetite for food, is intended to direct us when and in what quantity we ought to drink;

and so long as we confine ourselves to the fluids with which nature provides us, there is little chance of our going far wrong by listening to its calls. But when we come to the use of fermented and stimulating liquors, which excite a thirst not recognised by nature, the principle ceases to operate. At present, however, my observations apply entirely to the former, and I shall touch upon these other liquids when treating of diet in a subsequent part of the volume.

CHAPTER III.

MASTICATION, INSALIVATION, AND DEGLUTITION.

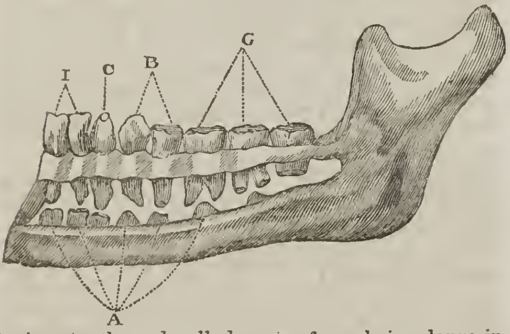
Mastication.—The teeth.—Teeth, being adapted to the kind of food, vary at different ages and in different animals.—Teeth classed and described.—Vitality of teeth and its advantages.—Causes of disease in teeth.—Means of protection.—Insalivation and its uses.—Gratification of taste in mastication.—Deglutition.

Having seen that a regular supply of nourishment is carefully ensured by the constantly returning impulses of appetite, we come next to examine the mode in which the food is prepared for becoming a constituent part of the animal machine, and endowed with the properties of life.

The first important step in the complicated process of digestion, is that by which the food, after being received into the mouth, is mixed with the saliva, and broken down till it becomes of a uniform pulpy consistence, fit for being easily swallowed and acted upon by the gastric juice on its arrival in the stomach. The term *mastication*, or *chewing*, is used to denote this operation; and the chief instruments by which it is performed are the teeth, the jaws, the muscles which move the jaws, the tongue, and the

salivary glands. On each of these we shall offer a few observations.

The TEETH vary a good deal according to the kind of food on which the animal is destined to live; but in man and the higher orders of animals they may be divided into three distinct groups: 1st, The *incisor*, or *cutting* teeth, being the eight broad and flat teeth, with a sharp cutting edge, seen in front of the upper and lower jaws, and marked I in the subjoined wood-cut, which represents one half of the lower jaw, and consequently only one fourth of the whole number of teeth. Thus we find only two incisors marked in the wood-cut, although there are eight of them in all, viz., two more are on the other side of the lower jaw, and four corresponding ones in the upper. 2d, The *cuspidati*, *canine*, or *dog* teeth, being the sharp-pointed, roundish-bodied teeth, four in number, one, C, in contact with each of the outer



incisor teeth, and called *canine* from being large in the dog and carnivorous animals, and used by them for the purpose of *seizing* and *tearing* their food; and, 3d, The *molares*, or *grinders*, B G, twenty in number, situated at the back part of the jaw, and so

called from their office being to grind or bruise the food subjected to their action.* The term *grinders*, however, is sometimes restricted to the three back teeth on each side, marked G, and seen to have double roots and a broad grinding surface; and the two intervening between them and the *cuspidati* are styled *bicuspidati*, or *double-speared*, from bearing a greater resemblance to a double-headed canine tooth than to the other grinders.

The teeth are modified in different animals to suit their habits of life. In herbivorous animals, the canine teeth, for which they have no use, are comparatively undeveloped; whereas in carnivorous animals, which tear their prey in pieces, the canine teeth are large, powerful, and pointed, and the incisors comparatively small. In these animals they constitute what are properly called the *tusks*, and in some species they are of a truly formidable character. The molar, or grinding teeth, differ in like manner, according to the nature of the food. In herbivorous and granivorous animals they are large and powerful, and to increase their efficacy the lower jaw admits of considerable lateral motion in a horizontal direction; whereas, in carnivorous animals, it admits of motion only upwards and downwards, as in opening and shutting the mouth. The lateral grinding motion is very evident in *ruminating* animals, such as the cow, which, after having filled its stomach with provender, is generally seen to lie down and *ruminate*, or *chew the cud*, as it is called —the rumination consisting in bringing up small masses of herbage from the stomach, and submitting them to a thorough mastication or grinding between its molar teeth, before being again swallowed and digested.

From this relation between the food and the or-

* In Latin, *cuspis* signifies the point of a spear; *canis*, a dog: *mola*, a mill; *incisor*, any thing which cuts.

gans of mastication, naturalists can tell with certainty, by simply inspecting the teeth, on what kind of food the animal to which they belong is intended to live; and as the teeth of man partake of the characters of those of both herbivorous and carnivorous animals, there cannot be a doubt that his diet was intended to be of a mixed kind, not confined exclusively to either the vegetable or the animal kingdom.

Hard and resisting as the teeth appear, they must still be regarded as living structures. Anatomically speaking, each tooth is divided into three parts: the *fang*, or *root*, implanted in the socket of the jawbone; the *neck*, or portion encircled by the gum; and the white *crown*, appearing above the gum, and covered with enamel.

The root of each tooth is perforated longitudinally by a small canal, through which the bloodvessels and nerve are admitted to its central parts. From these bloodvessels the tooth derives its nourishment when growing; but they afterward almost entirely disappear. From the nerve it derives that sensibility which makes us instantly aware of the contact of bodies either too hot or too cold with the teeth; and which, when the nerve is diseased, gives rise to the racking pain of toothache.

So effectually is life maintained in the teeth by this provision of vessels and nerves, that a tooth newly extracted from the socket of a young animal, and implanted in the fleshy comb of a cock, has been found to adhere and retain its vitality; and in like manner, if, in early life, a tooth extracted by accident be immediately replaced in its socket, it will generally adhere and live.

The visible part, or crown of the tooth, is covered with a very hard, white, ivory-looking substance, called *enamel*, which serves to prevent it from being worn down by friction, and into which neither bloodvessels nor nerves have been observed to penetrate.

Owing to this structure, the tooth can be safely exposed without sustaining damage—a privilege on which most persons will be disposed to place a higher value after having experienced the pains consequent upon injury of the nerve from a portion of the enamel being broken off.

An obvious advantage attending the vitality of the teeth is, that it enables them to accommodate themselves to the growth of the jaw and the rest of the system at the different periods of life. In early infancy, when the human being is designed to live exclusively on his mother's milk, which of course requires no mastication, and consequently no teeth, the latter are still imperfectly formed and entirely hidden in the jaw: it is only at the end of some months that the front or cutting teeth begin to appear; and the whole set of *milk*, *deciduous*, or *falling-out* teeth, twenty in number, is not completed till about or after the third year. In the course of three or four years more, however, growth has advanced so far that the first set of teeth no longer fill the jaw; and they soon begin to be displaced by the second, or permanent set, the gradual development of which commences at that period of life, and is not finished till the appearance of the last four grinders, or *wisdom-teeth*, about the age of maturity.

It is a curious fact, that the infant is born with the rudiments of both sets of teeth in the jaw at the same time, although neither makes its appearance till long after birth. The permanent teeth lie in a line under the milk-teeth, and it is from their growth, causing the gradual absorption of the roots of the first teeth, that the latter no longer retain their hold of the jaw, but drop out as soon as the others are ready to protrude. In the preceding wood-cut, the situation of the permanent teeth before they emerge from the jaw is rudely represented at A, where the outer surface of the jaw-bone has been removed on purpose to show the appearance of the roots. But

nothing of this kind is to be found in the adult jaw, the parts marked A being inserted in the plate merely to illustrate what was once the position which the permanent teeth occupied.

The changes in the condition of the teeth, it may be remarked in passing, indicate clearly what species of food nature has intended for us at different ages. In early infancy, when no teeth exist, the mother's milk is the only nutriment required; and in proportion as the teeth begin to appear, a small addition of soft farinaceous food, prepared with milk, may be made with propriety, and gradually increased. But it is impossible to look at the small jaw, moderate muscle, and imperfect teeth of early life, without perceiving that only the mildest kinds and forms of animal food are yet admissible, and that the diet ought to consist essentially of soft and unirritating materials. It is not till the permanent teeth have appeared that a full proportion of the ordinary kinds of butcher-meat becomes either beneficial or safe.

The teeth, being living parts, and at the same time endowed with a mechanical function, are liable to injury in both capacities. Being composed chiefly of earthy matter, such as phosphate and carbonate of lime, the contact of strong acids decomposes their substance, and leads to their rapid decay. Hence, the whiteness produced by acid tooth-powders and washes is not less deceitful than ruinous in its consequences; and hence also great caution is necessary in swallowing the acid drops frequently prescribed by the physician, which ought never to be allowed to come in contact with the teeth.

Being constantly moistened with saliva, the teeth have a tendency to become incrusted with the tartar, or earthy matter, which it contains in solution, and which is separated from it partly by the evaporation of the more fluid constituents in breathing, and partly by chymical decomposition. As this incrustation not

only destroys the beauty of the teeth, but also promotes their decay, it becomes an object of care to remove it as soon as it is formed; and the most effectual mode of doing so is to brush the teeth regularly twice a day—especially in the morning, when the quantity is greatest—with a brush dipped in soft water, till every particle is removed. The addition of any soft impalpable powder will assist in the effect; but nothing capable of acting chymically on the teeth, or of injuring them by friction, ought ever to be resorted to. Washing the mouth after every meal is also a good preservative.

When the teeth are not used for a time, and when digestion is impaired, the quantity of tartar which accumulates on them is very great. Hence they are always most incrusted in the morning, and in fevers and other affections where no food is taken, and the stomach is at the same time disordered. I have seen one instance in which a thick crust of tartar was removed by a dentist in the belief of its being a diseased tooth—the tooth itself on which it was formed being left in the jaw perfectly sound.

When the tartar is not duly removed, its presence injures the teeth, irritates the gum, and generally leads, sooner or later, to considerable suffering. The regular washing and brushing above mentioned ought, therefore, to be sedulously practised at every period of life, and taught as a duty to the young. When digestion is very vigorous, the health good, and the diet plain, and containing a full proportion of vegetable matter, the deposition of tartar seems to be diminished, and the teeth to be naturally of a purer white. Many rustics and savages thus possess teeth which would be envied in a town.

When digestion is impaired, and acidity prevails in the stomach, the mucous secretions in the mouth also become altered in character, and by their incessant contact injure and even destroy the teeth.

From this cause we often see the teeth in young people in a state of complete decay. They are in reality the subjects of chymical decomposition, and eaten away by the morbid secretions of the mouth; and hence, in such cases, we generally find. the individual complaining of heat and soreness of the tongue, gums, and mouth, and occasionally of the teeth being "set on edge."

Considered as *living* parts, the teeth require some additional care. In that capacity they are exceedingly apt to suffer from sudden changes of temperature. Being from their solidity rapid conductors of heat, their internal nerve speedily becomes affected by the alternations of temperature to which they are daily exposed, both in taking food, and in the change from a warm to a cold atmosphere. It is a not uncommon practice, for example, to take a glass of cold wine or water immediately after finishing a plateful of very hot soup; and it is quite usual to take tea and coffee, and every kind of meat, as hot as they can possibly be swallowed—than which practices it would be difficult to imagine any thing more hurtful to the teeth.

For the same reason, in going out at night from a warm room to the cold air, it is desirable to protect the teeth from the influence of the sudden change, by breathing through two or three folds of a silk handkerchief, or through a woollen *comforter*. When the teeth and lower part of the face are left exposed in such circumstances, rheumatism and toothache not unfrequently ensue from the direct impression of the cold air upon parts rendered more susceptible by the preceding heat.

The great source of injury to the teeth, however, both in childhood and in mature age, is disordered digestion. If the health be good, and the stomach perform its functions with vigour, the teeth will resist much exposure without sustaining injury. But if these conditions fail, they will rarely continue long unscathed.

It is almost always from the latter cause that, in infancy, teething so often gives rise to serious constitutional disorder.

Something more, however, than the mere action of the teeth and jaws, is required to prepare the morsel for being swallowed. If we take a bit of dry biscuit or mealy potato into the mouth, and attempt to masticate it, we encounter at first no small difficulty from the stiffness and resistance of the dry mass, and feel instinctively that it would be in vain to attempt to swallow it, until moistened either by continued mastication or by the admixture of fluid from without. In ordinary states of the system, accordingly, a fluid called *saliva*, or *spittle*, is copiously secreted and poured into the mouth for this very purpose; and the process by which its due admixture with the contents of the mouth is accomplished, is called the *insalivation* of the food.

To provide this necessary fluid, and to connect its supplies directly with the process of mastication to which it is subservient, several glands for its secretion have been placed in the immediate neighbourhood of the mouth and jaws, in such a way that the latter cannot be opened and shut without affording them a stimulus, and still farther increasing the secretion which the presence of the morsel is itself sufficient to begin. From this arrangement it follows, that the more perfectly mastication is performed, the more thoroughly does the morsel become impregnated with the salivary fluid, and the better fitted is it rendered for subsequent deglutition and digestion.

The apparatus of mastication varies according to the kind of food on which the animal is destined to live; but in the higher orders of animals, it consists essentially of the parts already mentioned. In some animals, however, which live on soft gelatinous food—as the whale—no teeth are to be found, because their peculiar power is not required. In

others—as the granivorous, or grain-eating birds—the grinding or *triturating* process is effected not in the mouth, but in the gizzard, where the food (mixed with gravel, which the animal is instinctively impelled to swallow for the purpose) is effectually bruised and softened down by the strong muscles which constitute the greater part of its substance. In these instances the gravel is the grinding instrument, and without its presence digestion cannot be carried on, any more than it could in man without the agency of teeth.

The degree of mastication required varies also, according to the mode of life of the animal, and the digestibility of its food. Animal food, for example, being easy of digestion, requires less mastication than vegetable food, which is more difficult. This is so much the case, that most animals which live on fresh vegetable matter spend half their waking hours in *ruminating*, or re-masticating the food, which they have already cropped and stored up for the purpose in one of their four stomachs. To this necessary act in them, Providence seems to have attached a high degree of gratification, for the very purpose of ensuring its regular performance.

Man, being naturally omnivorous, or adapted for the digestion of both animal and vegetable substances, holds, as it were, an intermediate place in regard to the rapidity of mastication. He neither is obliged to ruminate like the cow, nor can beneficially bolt his food with the rapidity displayed by beasts of prey. His object is merely to reduce the alimentary mass to a soft and pulpy consistence, and digestion is promoted or retarded in exact proportion as he approaches or falls short of this point. Hasty mastication is consequently injurious, because it prevents the food from being sufficiently broken down and impregnated with saliva; and the more uncommon error of protracted mastication is also injurious, owing to the undue dilution which the

mass sustains from the overflow of the salivary secretion.

Due mastication being thus essential to healthy digestion, the Creator, as if to ensure its being adequately performed, has kindly so arranged, that the very act of mastication should lead to the gratification of taste—the mouth being the seat of that sensation. That this gratification of taste was intended, becomes obvious, when we reflect that, even in eating, nature makes it our interest to give attention to the process in which we are, for the time, engaged. It is well known, for example, that when food is presented to a hungry man, whose mind is concentrated on the indulgence of his appetite, the saliva begins to flow unbidden, and what he eats is consumed with a peculiar relish. Whereas, if food be presented to an individual who has fasted equally long, but whose soul is absorbed in some great undertaking or deep emotion, it will be swallowed almost without mastication, and without sufficient admixture with the saliva—now deficient in quantity—and consequently lie on the stomach for hours unchanged. A certain degree of attention to taste, and to the pleasures of appetite, is, therefore, both reasonable and beneficial; and it is only when these are abused that we oppose the intentions of nature.

From the existence of this intentional relation between mastication and the salivary secretion, the latter is always most copious in those creatures whose food requires continued mastication. In ruminating animals, accordingly, the salivary glands are numerous and of great size, while they are at the same time so situated, that the play of the muscles in the act of rumination communicates to them a proportionate stimulus. In those, again, which do not masticate at all, but swallow their food entire, there is scarcely any salivary secretion, and the glands appropriated to it are very small. Birds,

and many fishes and reptiles, belong to the latter class.

From the foregoing explanation of the object and conditions of mastication, the reason will be apparent why *fluids* do not require to undergo that process, and also why dry mealy substances stand in need of protracted chewing before they can be easily swallowed. When hot spicy food is taken into the mouth, the secretion of saliva is immensely increased, obviously for the purpose of diluting the excess of stimulant before it shall be allowed to reach the stomach. But when the food is of a mild and unirritating quality, much dilution is unnecessary, and the secretion is accordingly moderate.

The chief purpose of mastication, then, is evidently the minute division of the aliment, so as to admit of its being easily acted upon by the gastric juice when received into the stomach. Dr. Beaumont, however, seems to me to go too far in inferring, that "if the *materia alimentaria* could be introduced into the stomach in a finely divided state, the operations of mastication, insalivation, and deglutition, would not be necessary." It would require a more extensive range of experiments than that which he has made, to prove that "aliment is as well digested and assimilated, and allays the sensation of hunger as perfectly, when introduced directly into the stomach (through an opening in the side) in a proper state of division, as when the usual previous steps have been taken."* It is quite true that mastication and deglutition are chiefly mechanical processes; but it is difficult to believe that so much care would have been taken to provide a proper supply of a fluid of a constant and *peculiar* character like saliva, if water were capable of answering the purpose as well, and if saliva were useful *only* in lu-

* Experiments and Observations on the Gastric Juice and the Physiology of Digestion, by William Beaumont, M. D. Plattsburgh, 1833, p. 67.

brieating the food. There subsists, moreover, between the sense of taste and the power of digestion, a eertain relation, which renders it more than probable that the active gratification of the former during mastication is favourable to the produetion and flow of nervous energy towards the stomach, and eonsequently in so far conducive to the healthy performance of digestion, that even in that point of view insalivation could not easily be dispensed with. Dr. Beaumont's experiments, however, abundantly demonstrate that Montègre, and those who, along with him, eonsider the saliva as the *principal* agent in digestion, have not a shadow of foundation for their opinion.

When unmasticated food is introduced into the stomaeh, the gastric juice acts only upon its surface, and other purely chymical changes sometimes eommence in its substance before its digestion ean be effected. Hence often arise, especially in children, those pains and troubles, that nausea and acidity, consequent on the continued presenee of undigested aliment in the stomach. By a peculiarity of constitution, however, the stomach will not long retain food whieh it eannot dissolve. After a number of hours,—varying, according to the state of health, from one or two to ten, or even twenty,—it is either rejected by vomiting, or transmitted unehanged to the intestine, where its presence irritates and gives rise to colic, flatulenee, bowel-eomplaints, and, in delicate children, not unfrequently to convulsions. Hence another proof of the importance of slow and deliberate mastication.

As soon as the morsel has been thoroughly mastieated and impregnated with saliva, it is ready for transmission to the stomaeh. To this part of the proeess the term *deglutition*, or *swallowing*, is applied.

Immediately at the baek part of the mouth several passages present themselves, leading in different

directions—one upwards and forward into the nose, another downwards and in front into the windpipe, and a third downwards and behind into the *œsophagus*, or *gullet*, and stomach. The last is the passage taken by the food, and the violent coughing and occasional suffocation induced when it accidentally passes into the windpipe, are but a specimen of the serious evils which would be continually occurring if some provision were not made to obviate the danger, while the rarity with which such accidents actually happen, proves the almost unfailing efficacy of that which has been devised.

The passage of the food into the nostrils is prevented by the interposition of a moveable fleshy fold or valve hanging down from the palate, and visible at the back part of the mouth; this, in the act of swallowing, is stretched backwards so as to extend to the back part of the throat, and thus entirely shut up the opening into the nostrils. The passage into the windpipe, again, is protected by a cartilaginous lid or covering called *epiglottis* (from *επι epi*, upon, and *γλωττις glottis*, the tongue), which projects backwards from the root of the tongue, and conducts the morsel over the *glottis* or opening of the windpipe. The epiglottis, however, is greatly assisted in this operation by that rising upwards and forwards of the gullet and windpipe to meet the morsel, of which we are conscious in the act of swallowing, and the effect of which is in some degree to hide the glottis under the backward projection of the root of the tongue, and allow the morsel to drop past it into the gullet.

Once fairly in the gullet, the course of the food into the stomach is easy enough. The gullet is simply a round tube, made up of two rows of muscular or fleshy fibres, the one longitudinal, and the other transverse and circular, with a soft, moist lining membrane to facilitate the transmission of its contents. When the morsel is introduced, its upper

part contracts involuntarily, and pushes the mass downwards; the portion now reached contracts in its turn, and propels it farther; and so on in succession till it arrives at the stomach.

Deglutition, or *swallowing*, is thus a more complicated operation than at first sight it appears to be. On looking at any person eating, one is apt to think that the morsel passes along the gullet into the stomach by its own weight; but we speedily perceive the error when we recollect that, in the horse and the cow for example, the mouth is on a level with the ground when feeding, and that the morsel is consequently propelled upwards into the stomach against its own gravity. It is well known also, and often made a matter of public exhibition, that a man can swallow even liquids when standing on the crown of his head, with the natural position of the stomach reversed.

Deglutition is easier and quicker when the appetite is keen, and the alimentary bolus or morsel is moist and properly softened. It is slow and difficult when the morsel is dry and mealy, and the appetite nauseated. In vomiting, the action of the muscular fibres is *inverted*, or proceeds from the lower end of the gullet towards the mouth; and hence the object is carried upwards instead of downwards, as in the natural order.

CHAPTER IV.

ORGANS OF DIGESTION—THE STOMACH—THE GASTRIC JUICE.

Surprising power of digestion.—Variety of sources of food.—All structures, however different, formed from the same blood. —General view of digestion, chymification, chylification, sanguification, nutrition.—The stomach in polypes, in quadrupeds, and in man.—Its position, size, and complexity, in different animals.—Its structure; its peritoneal, muscular, and villous coats; and uses of each.—Its nerves and bloodvessels, their nature, origins, and uses.—The former the medium of communication between the brain and stomach.—Their relation to undigested food —Animals not conscious of what goes on in the stomach.—Advantages of this arrangement.—The gastric juice the grand agent in digestion.—Its origin and nature.—Singular case of gunshot wound making a permanent opening into the stomach.—Instructive experiments made by Dr. Beaumont.—Important results.

If, in the whole animal economy, where all is admirable, there be one operation which, on reflection, appears more wonderful than another, and which evinces in a higher degree the prodigious resources and power of the Creator in fashioning every thing to his own will, it is perhaps that by which the same kind of nutriment is extracted from the most opposite varieties of food consumed by living beings. For, singular as it may appear, recent researches tend to establish the fact, that, even in animals differing so widely in their aliment as the herbivorous and carnivorous quadrupeds, the ultimate products of digestion in both—the chyle and the blood—are *identical* in composition, in so far at least as can be determined by their chymical analysis.*

* See Roget's Bridgewater Treatise, note at p. 58, vol. ii.

Remarkable, however, as this uniformity of result undoubtedly is, it becomes still more striking when we contemplate the variety of sources from which food is derived for the support of animal life. To use the words of an able writer already quoted, "There is no part of the organized structure of an animal or vegetable, however dense its texture or acrid its qualities, that may not, under certain circumstances, become the food of some species of insect, or contribute in some mode to the support of animal life. The more succulent parts of plants, such as the leaves or softer stems, are the principal sources of nourishment to the greater number of larger quadrupeds, to multitudes of insects, as well as to numerous tribes of other animals. Some plants are more particularly assigned as the appropriate nutriment of particular species, which would perish if these ceased to grow: thus, the silkworm subsists almost exclusively upon the leaves of the mulberry-tree; and many species of caterpillars are attached each to a particular plant, which they prefer to all others. There are at least fifty different species of insects that feed upon the common nettle; and plants of which the juices are most acrid and poisonous to the generality of animals, such as euphorbium, henbane, and nightshade, afford a wholesome and delicious food to others."* Nor are the precision and accuracy with which the same fluid—the blood—affords to every structure of the body the precise species of nourishment or secretion which its elementary composition requires, however different each may be from the rest in chymical qualities, less admirable and extraordinary than its own original formation from such a variety of materials. To bone, the blood furnishes the elements of bone with unerring accuracy; to muscle the same blood furnishes the elements of muscle,—to nerves the

* See Roget's Bridgewater Treatise, vol. ii., p. 59.

elements of nerve,—to skin the elements of skin,—and to vessels the elements of vessels;—and yet, while each of these differs somewhat in composition from the others, the constituent elements of the blood by which they are furnished are everywhere the same.

Similar phenomena, indeed, occur in the vegetable world; but this, instead of diminishing our wonder, rather tends to augment it. The same elements, extracted from the same soil, are converted into every variety of vegetable product—into leaves of every shade of green, flowers of every form and teint, and juices of every quality, from the deadly poison up to bland and life-supporting milk. Nay, even in the same plant—as in the poppy—we sometimes find the seeds and the capsule which covers them endowed with the most opposite properties.

It would be very interesting to discover by what resources nature thus effects the production of the same kind of nutritive fluid, or *chyle*, from so great a variety of substances, and apportions to every part the precise elements of which it stands in need; but it is doubtful whether the human faculties were ever designed to penetrate so far into the modes of vital action, and, in the meantime, it will be better for us to confine our attention to that branch of the inquiry which bears a direct reference to our own welfare. We know already, that certain organs are concerned in the processes above mentioned, and that these organs act under the regulation of certain general laws. If we make ourselves acquainted with, and carefully fulfil these laws, we reap a rich reward in the enjoyment of sound and vigorous digestion. Whereas, if, either from ignorance or from carelessness, we neglect their fulfilment, we bring upon ourselves a severe punishment in the form of dyspeptic or nervous disease. Assuredly, then, alternatives like these ought

to excite some desire for information in the minds even of the most indifferent.

Before, however, commencing a description of the organs concerned in digestion, it will be useful to take a general view of the different stages of preparation through which the food passes, between its reception into the stomach and its *assimilation*, or ultimate conversion into a constituent part of the animal body, and becoming endowed with the properties of life. The reader will thus be better enabled to understand the meaning of various terms and expressions, the frequent use of which it is almost impossible to avoid, even in the beginning of our exposition.

When the food is received into the stomach, it is there subjected to the action of a solvent fluid, called the *gastric* or *stomach juice* (from γαστηρ, *gaster*, stomach), by which it is gradually converted into a soft grayish and pultaceous mass, called *chyme* (from χυμος, *chymos*, humour or juice); whence the process is called *chymification*, or *chyme-making*. The chyme, as fast as it is formed, is expelled by the contractile power of the stomach into the *duodenum* (from *duodenus*, consisting of twelve, because it is supposed to be about twelve inches long), or first portion of the intestines. It there meets with the *bile* from the liver, and with the *pancreatic juice*, which very much resembles the saliva, from the *pancreas*, or *sweet-bread* (πας, *pas*, all, and κρεας, *kreas*, flesh, it being of a fleshy consistence), a large gland which lies across the spine a little below the stomach, and is marked P in the wood-cut given in the chapter on Chylification. By the action of these two fluids, the chyme is converted into two distinct portions,—a milky white fluid named *chyle* (from χυλος, *chylos*, chyle), and a thick yellow residue. This process is called *chylification*, or *chyle-making*. The chyle is then sucked in by absorbent vessels,

extensively ramified on the inner membrane or lining of the bowels, and sometimes named, from the white colour of their contents, *lacteals*, or *milk-bearers* (from *lac*, milk). These lacteals ultimately converge into one trunk, named the *thoracic duct*, or *chest-pipe* (from its course lying through the *thorax* or *chest*), and which terminates, as will be seen in a subsequent cut, in the great vein under the clavicle, or collar-bone, hence called *subclavian* vein, just before the latter reaches the right side of the heart; and there the chyle is poured into the general current of the venous blood.

But although thus mingled with the blood, the chyle is not yet sufficiently capacitated for its duties in the system. To complete its preparation, it still requires to be exposed to the action of the air during respiration.* This is accordingly done by its passing through the lungs along with the dark or venous blood, which stands in need of the same change. In the course of this process, both the chyle and the venous blood are converted into red, arterial, or nutritive blood, which is afterward distributed by the heart through the arteries, to supply nourishment and support to every part of the body. Hence the change which takes place in the lungs is properly enough named *sanguification*, or *blood-making*.

The thickish yellow residue left in the *duodenum* after the separation of the chyle from the chyme, is that portion of the food which affords no nourishment, and which, after traversing the whole length of the intestinal canal, and undergoing still farther change, is thrown out of the body in the shape of *fæces*, or excrement. But in this course its bulk is increased, and its appearance changed, by the addition of much waste matter, which, having already served its purposes in the system, is at last, as will

* For a full explanation of the nature of respiration, see the author's Principles of Physiology, &c., chap. vii.

be afterward shown, thrown out by the same channel.

With this general view of the nature of Digestion before us, we can now examine more satisfactorily the structure and mode of action of the organs concerned in effecting it. *Chymification* being the first step in the complicated process, we shall begin with the organ by which it is performed, namely, the STOMACH.

In the lowest class of animals,—the hydra, for example, which belongs to the order of gelatinous polypi, and abounds in stagnant pools,—the stomach is like a simple bag, devoid of any peculiar organization; or, more properly speaking, the animal itself is nothing more than a living stomach; for the minutest inspection can discover in it no trace of any thing like vessels, nerves, brain, lungs, heart, or other known organ. Even the experienced eye of Cuvier, aided by a powerful microscope, could detect in their structure nothing more than a transparent parenchyma, full of darkish grains or points, and offering no trace of any distinguishable organs.* In form, the animal somewhat resembles the finger of a glove, the hollow in the centre being appropriated for the reception of its food; and yet with all this simplicity of structure, it not only moves and swims, but seizes its prey by means of its tentacula, thrusts it into its cavity, and digests it visibly—"*à vue d'œil.*" And what is still more strange, when it is turned inside out, the surface, which was formerly the exterior of the body, now digests as actively and efficiently as if it had never served any other purpose.

Animals of this very simple description have obviously no need of vessels of any kind, because every part of the internal surface of the body is in immediate contact with its food, and seems to imbibe or

* Cuvier's Règne Animal, vol. iii., p. 295.

absorb *directly* all the nourishment which it requires; for vessels are wanted only where digestion goes on in one part, and the nutriment requires to be carried to another—a vessel being neither more nor less than a tube for conveying the requisite nourishment from the place in which it is prepared to parts where its presence is necessary. Owing to this extreme simplicity of organization, a hydra may be cut into pieces, each of which will become a perfect animal. But, in proportion as we ascend in the scale of creation, the organization becomes more complicated, and the functions more numerous, and also more dependant on each other; so that, when we arrive at man—the highest of all—we find that the loss or injury of any vital organ puts a stop to or impairs the action of all the rest. It is impossible, however, in an elementary work like this, to trace the gradation through the different series of animals. We must confine our examination to man, and only borrow from other creatures such illustrations as may be necessary for throwing light upon the human structure.

In man, then, the stomach is a large membranous and muscular bag, lying under the convexity of the lower ribs of the left side, and stretching towards the right a little beyond the hollow commonly called the pit of the stomach. In shape it somewhat resembles the bag of a bagpipe, as will be seen from the figure on page 71; its left or larger extremity being in contact with the ribs, and its right or narrow extremity situated under the pit of the stomach.

Its position (St^{m}.) relatively to the chest, bowels, and liver, will be understood by inspecting the subjoined figure, already given in the former volume. It is separated from the cavity of the chest by the diaphragm or midriff D D, with which its upper surface is in immediate contact, and through which the gullet passes to enter its left extremity. Its

right or *pyloric* extremity, marked P in the cut on the opposite page, lies close to the lower surface

of the liver (Livr.), the latter being a little displaced to show its situation. On the lower surface it has the appearance of resting on the intestines, as if imbedded among their folds.

The parts of the stomach which have received names and require to be noticed, are,—the *cardiac* orifice (marked C in the next figure, and so named

from being near the *κεαρ*, *kear*, or heart), in which the gullet terminates, and through which food and drink are introduced; P, the *pylorus*, or pyloric orifice (from *πυλωρος*, *pyloros*, a *gate-keeper*, because it allows none but digested food to pass out), where

the intestine called the *duodenum* begins, and through which the chyme passes after digestion is completed, and which, when the stomach is full, is nearly on a level with the cardia, although when empty it is lower; SS, the *smaller arch* or *curvature;* and GGG, the *greater arch* or *curvature.* The spleen is attached to that part of the larger arch marked with dotted points. From the situation of the cardia C. and its connexion with the gullet, it will be at once perceived that this forms one of the points of attachment by which the stomach is retained in its place.

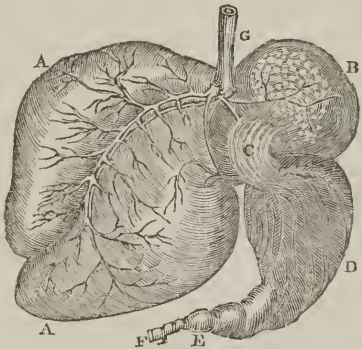
In size, the stomach varies much in different individuals as well as in different animals, according to the bulk and quality of their food. As a general rule, it is larger among the labouring poor than

among the rich, as the former require a larger quantity of their inferior food to obtain from it an equal amount of nourishment. For the same reason, animals which subsist on vegetable substances have a very capacious stomach, while those subsisting on animal or concentrated food have it simple and small. In man, its capacity may be diminished or augmented within certain limits by corresponding modifications of diet. In some gluttons, and in cases of diseased appetite, it has been found of enormous dimensions; but this rule does not always hold, for the stomach is sometimes smaller than usual in immoderate eaters, and then its contents pass through only partially digested.

In accordance with this relation between the capacity and structure of the organs of digestion and the quality of the food, the stomach and intestines are found to be very small and short in carnivorous quadrupeds and birds of prey, which are intended to live on concentrated aliment. The same is the case with the *granivorous*, or *grain-eating* birds, as their food also is contained in a small bulk. But in herbivorous animals—in the food of which the nutritive principle forms a very small proportion of the whole, perhaps not one twentieth, and which consequently require a large bulk of it for their sustenance—the digestive apparatus is on a large scale, as any one may conceive in a moment, by comparing the portly protuberance of the cow with the lank paunch of the greyhound. The cow, in fact, is little else but a living laboratory for the conversion of vegetable into animal matter; and accordingly, not only is its stomach large and complex, but its intestinal canal is nearly twenty-four times the length of its body; whereas, in some carnivorous animals, the whole intestine does not exceed once their own length.

In ruminating animals, such as the sheep and ox, the stomach, as will be seen from the annexed

figure, not only is large, to adapt it to the bulky nature of their food, but is complicated in its structure, to fit it for effecting the great changes which vegetable aliment requires to undergo before it can be converted into blood. It may, indeed, be said



to consist of four distinct stomachs conjoined. In the first of these, AA, termed the *paunch*, the herbage is deposited when first swallowed, after hasty and ineffectual mastication. It there undergoes a kind of maceration, or steeping, in a fluid provided for the purpose; after which it passes from the paunch into a smaller bag, called the *reticulum*, or bonnet, B, which in some animals, such as the camel and dromedary, is designed exclusively as a reservoir for water, which, being there stored up in large quantities, ready for use when wanted, fits them in a wonderful manner for travelling through the arid deserts where no water is to be obtained, and where, without such provision, they would of course soon perish. So admirably is the reticulum adapted for this special purpose, that the water contained in it undergoes little or no change either i

quality or quantity, although, if it were collected in the ordinary digesting stomach, it would be entirely absorbed in the course of a few minutes. It is not even mixed with the food which is swallowed after it, as the animal has the power of directing solids at once into the other cavities. From the reticulum, the alimentary mass is again returned to the mouth, there to be thoroughly masticated and mixed with the saliva; after which it descends a second time through the gullet; but instead of passing, as before, into the paunch, it enters the third bag, *omasum*, or many-plies, C, where it undergoes farther changes, and is then transmitted to the fourth portion, D, adjoining the pylorus, and named *ab-omasum*, or red-bag. The last portion is exactly similar in structure and in function to the simple stomach of man and the other mammalia, and is, in fact, the true stomach, the other three being merely preparatory organs.

The first part of the process, by which the food is taken hastily into the paunch, and afterward sent back to the mouth in detached portions, for farther mastication, is called *rumination*, or *chewing the cud*, and those species which perform it are thence called *ruminating* animals. Sheep and cows may be seen lying ruminating in pasture-fields after having cropped as much herbage as fills the paunch; and feeding is thus rendered to them a source of prolonged enjoyment.

In those birds, again, which live on hard grain and seed, and possess no organs of mastication wherewith to bruise or grind them down, another modification of the digestive apparatus is found. Nature has furnished them with a membranous bag, called a *crop*, or *craw*, into which the food is received, and where it is slightly softened by a mucous fluid secreted from the surface of the bag. Thus prepared, it is transmitted into an organ analogous to the stomach of other animals, and called the *gizzard*,

which has a very singular structure. Its walls are composed of four distinct portions of thick, tough, muscular substance, a large one at each side of the cavity, and a small one at each end. The inner surface of the muscle is lined with an extremely callous cuticle, approaching in hardness to cartilage or horn. When the moistened grain is introduced into the gizzard from the crop, the muscular walls of the gizzard enter into powerful action, and, by their alternate contraction and relaxation, bruise the grain as between two grindstones. In some birds their action is assisted by a quantity of small gravel, purposely swallowed along with the food; and it is well known to seamen that poultry never thrive on a voyage, however well they may be fed, if gravel or coarse sand, as well as food, is not placed within their reach. Mr. Hunter has counted as many as a thousand small stones in the gizzard of a common goose.*

The astonishing force with which the muscles of the gizzard act, and the resistance of its lining membrane, may be conceived from the experiments of Spallanzani and Reaumur, who compelled geese and other birds to swallow needles, lancets, and other sharp metallic bodies, and, on afterward killing them, regularly found the points broken off, and the edges blunted, without any injury having been sustained by the gizzard itself.

In STRUCTURE, the stomach of both man and animals consists of three membranous layers or coats, of follicles or glands, and of numerous bloodvessels and nerves.

The *first* or *external* layer is the smooth, glistening, whitish membrane, which is familiar to all who have

* The above descriptions and figure are taken, with slight alterations, from the Treatise on Animal Physiology in the Library of Useful Knowledge.

ever seen an animal opened, or hanging at a butcher's door. It is a fold of the tough shining membrane, called *peritoneum* (from περιτεινω, *periteino*, I extend round), which lines the abdomen, and constitutes the outer covering of all the abdominal organs. Its use is obviously to strengthen the substance of the stomach, to assist in binding down this and the other organs in their respective situations, and, by the smoothness and constant moisture of their surfaces, to enable them to move upon each other, and adapt themselves freely to their different states of emptiness and distention.

The *second*, *middle*, or *muscular* coat consists of fleshy fibres, one layer of which, running longitudinally from the cardia to the pylorus, seems to be a continuation of the longitudinal muscular fibres of the gullet: another runs in a circular direction, embracing, as it were, the stomach from one curvature to the other, and constituting what are called the transverse fibres. A third and more internal layer of this coat is spoken of by Sir Charles Bell, as a continuation of the circular fibres of the gullet, which divide into two parcels, the one distributed over the left or larger end, and the other over the pyloric or narrower end.

The uses of the *muscular* coat have, as we shall afterward see, a direct reference to the special function of digestion. By the joint action of its longitudinal and circular fibres, the stomach is enabled to contract, and shorten its diameter in every direction, so as to adapt its capacity to the volume of its contents; while, by their successive action, or alternate contraction and relaxation, a kind of churning motion is produced, which contributes greatly to digestion by the motion which it imparts to the food, and the consequent exposure which it effects of every portion of it in its turn to the contact of the gastric juice.

The force and rapidity of these muscular contractions are modified by the more or less stimulant nature of the food, the state of health, exercise, and other circumstances; but, according to Dr. Beaumont, the ordinary direction in which they take place, and the course which they impart to the food, are as follows:—

The alimentary *bolus* or morsel, on entering the cardiac orifice, turns to the left, follows the line of the great curvature of the stomach towards the pylorus, returns in the line of the smaller curvature, makes its appearance again at the cardia, and then descends as before to the great curvature, to undergo similar revolutions till digestion be completed. Each revolution occupies about from one to three minutes, and its rapidity increases as chymification advances.

In treating of muscular action in the former volume, I pointed out (p. 95) the necessity of the co-operation of a nervous stimulus to produce the result; and remarked that there are two kinds of muscles, one called the *voluntary*, which contract at *the command of the will*, and the other the *involuntary*, over which the will has no control, and which act only in obedience to their own peculiar stimuli. Of the latter description are the muscular fibres of the stomach. They contract when the stimulus of food is applied to them; but we can neither contract nor relax them by an effort of the will, nor are we even conscious of their existence.

It is, indeed, fortunate for us, that the necessary motions of the stomach are not intrusted to our guidance, like those of the hand or foot. Supposing that we were to eat three meals a day, the digestion of each requiring three or four hours,—and that its management depended entirely upon our superintendence,—our whole attention would be required to the process, to the exclusion of every other duty, for ten or twelve hours a day; and every time

that our thoughts wandered for a few minutes, digestion would stand still, and the stomach be disordered by the chymical decomposition of the food which would ensue, so that it would be impossible for us to dedicate any time either to business or to social enjoyment. But from all these inconveniences we are entirely freed by the stomach being placed under the dominion of the involuntary nerves, and so constituted as to perform its functions without any aid from our will.

The *third* and innermost coat, called the *mucous*, or *villous*, is that smooth, unequal, velvety membrane, of a reddish-white or pale pink colour, which lines the internal surface of the stomach. From being of much greater extent than the other two coats, its surface is thrown into *rugæ*, *plicæ*, *folds*, or *wrinkles*, which are simple in man, but very marked in some animals, as seen familiarly in *tripe*. The subjoined wood-cut, from the Library of Useful Knowledge, will give some notion of their appearance Near the pyloric orifice the villous coat is

doubled on itself, so as to form a ring, called the *valve* of the pylorus, the object of which is to prevent the too early exit of the food; this object, however, it accomplishes, not by any contractile power of its own, but by the aid of a layer of muscular fibres lying behind it. The villous coat is con-

stantly covered with a very thin, transparent, viscid mucus, and its folds are always best seen in those who die suddenly. After disease, when the stomach is relaxed, they frequently disappear.

In addition to the folds just described, the mucous coat contains a great number of spheroidal glandular bodies or *follicles*, some of them scarcely larger than pinheads, which lie immediately beneath and almost incorporated with it, and which are most numerous near the pylorus. Physiologists are not entirely agreed, whether the fluid secreted by these follicles be the *gastric juice*, or merely the mucus already referred to as lubricating the internal surface of the stomach. The latter, however, is the opinion generally entertained, and the one which is supported, as we shall afterward see, by the strongest evidence; the gastric juice being, in fact, secreted directly from the capillary or *hair-sized* vessels in which the minute branches of the arteries terminate.

Of the *nerves* and *bloodvessels* supplying the stomach it is unnecessary to say much. We shall afterward have occasion to notice the former at some length, and to the general reader the origin and distribution of the bloodvessels are as unimportant as they would be difficult of comprehension; for the nature of the red blood is the same by whatever artery it is supplied, and that of the dark blood the same by whatever vein it is returned to the heart. All that it is important to know is, that the stomach receives a large supply of blood by means of numerous bloodvessels, the principal of which, as represented on the wood-cut at page 71, follow the course of the greater and smaller curvatures GG and SS, and send off innumerable small branches as they proceed to every part of the stomach. The *coronary* artery, and the *pyloric* branch of the *hepatic*, or liver artery, go to the smaller curvature, while another branch of the hepatic, and one from the *splenic*, or spleen artery, are ramified on the larger curvature.

In determining the uses of the internal or villous coat of the stomach, we must begin by considering separately that of each of the elementary structures of which it is composed—its follicles, bloodvessels, and nerves—and the nature of the peculiar secretion, the gastric juice, to which it gives rise.

The FOLLICLES pour out the bland viscid mucus which lubricates the internal coat, and protects it in some degree from sustaining injury by the immediate contact of irritating bodies. When the follicles are diseased, as in what is called *water-brash*, they sometimes throw out a large quantity of a ropy transparent fluid, which oppresses the stomach and impairs digestion.

The BLOODVESSELS of the stomach, like those of every other part, are more or less active, according to the energy of its functions at the time. In treating of the laws of exercise as applicable to all living parts,* I took considerable pains to point out the relation which the Creator has established between the activity of every organ and the energy of its vital functions. When the brain is exercised and the mind active, an augmented flow of blood takes place towards it to support its increased action. When it is inactive and the mind indolent, a diminished flow of blood occurs. In like manner, when the muscles are called into vigorous action, the circulation of the blood through them is quickened, and their nerves are more than usually excited: greater waste of material is caused by the increase of activity, and more blood, consequently, is required to repair the waste and sustain their tone. This law was so well known to the older writers, that it was announced by them as an axiom in the very comprehensive phrase, *Ubi stimulus, ibi affluxus*—"*Wherever a stimulus is, there is also an afflux.*"

The stomach forms no exception to this general

* Principles of Physiology, &c.

law of the animal economy. When it is empty and idle, it is contracted upon itself into comparatively small bulk ; and its bloodvessels become shortened and tortuous in a corresponding degree. The result is both a diminution of their calibre and a slower circulation through their branches. But when the stomach is full and active, the bloodvessels have free scope, their tortuosity disappears, their diameter enlarges, and the circulation through them becomes quicker, and fit for the rapid secretion of the mucous and gastric fluids in the quantities which we have seen to be required for the fulfilment of digestion. Accordingly, when the latter process is going on, the small arterial branches ramified on the mucous coat of the stomach become so multiplied and distended, as to impart to it a deeper red colour than it has when the stomach is empty. The increased afflux of red or arterial blood to the stomach during digestion, is not merely inferred from the analogy of other organs. Many opportunities have occurred of ascertaining the fact; and, as I shall have occasion to mention, Dr. Beaumont very often SAW it take place.

A corresponding change occurs in the *veins* of the stomach during digestion. Their diameter becomes enlarged, their course more straight, and the current of blood through them more rapid. As the minute or capillary extremities of the arteries open upon the inner surface of the stomach, and there *exhale* a fluid secretion, so the corresponding venous capillaries likewise open upon the same surface, and *inhale* or *absorb* fluid, which they carry into the general circulation. The rapidity with which this absorption sometimes takes place is almost incredible ; for a large draught of water may be thus taken up in a few minutes. Fluids mixed with camphire or other strong-scented substance have been given to animals as an experiment, and, on killing them shortly afterward, the peculiar smell has been de-

tected in the blood. Liquids are thus not digested, but simply absorbed.

Rapid, however, as the process is, poisons which enter the system by absorption do not by any means act so instantaneously as those which directly affect the nervous system.

In regard to the peculiar influence which each of the NERVES ramified on the stomach exercises on its functions, much difference of opinion still prevails. We may, however, gather some useful notions by adverting to the different sources whence they are derived, and comparing these with the purposes for which we know from analogy that different kinds of nerves are required.

Strictly speaking, the nervous filaments supplied to the stomach proceed from three distinct sources, and may be held to fulfil as many distinct uses. In apparent accordance with this, we observe three, if not four, distinct classes of operations going on in that organ, each of which may, from analogy, be presumed to require a distinct nerve for its performance. These are, first, the pleasurable consciousness attendant on the presence of wholesome food in a healthy stomach, and which becomes painful and disagreeable when the stomach is diseased or the food of improper quality; secondly, the peristaltic or muscular motion which commences the moment food is swallowed, and continues till digestion is completed; and, lastly, the different processes of circulation, nutrition, secretion, and absorption, which go on in the component tissues of the stomach and support its life. To these ought perhaps to be added the sensation in which the feeling of appetite originates, and which we have already seen to be connected with the pneumogastric nerve. But as it is still uncertain whether it and the first of the three now named may not be modifications of the same thing, I shall not insist on considering them as different.

Although we cannot state positively what particular nerve presides over each of these functions, it may be mentioned that strong presumptive evidence has been adduced, particularly by Brachet, to show that the *pneumogastric** nerve is charged with the involuntary motions of the stomach, as well as with the sense of its condition. Food being the natural stimulus of that organ, as light is of the eye, its presence alone, without and even against the will, suffices to produce the contraction of its muscular coat; and accordingly, the more stimulating the food, the more rapid and vigorous is the muscular contraction which it excites. So far, indeed, do the stomachic nerves respond to their own stimuli, that, if nauseous or other irritant and indigestible substances be swallowed, the action of the museular coat becomes so violent as to excite sympathetically the simultaneous contraction of the diaphragm and abdominal muscles, to aid in their immediate expulsion by vomiting; and this is the reason why such substances are in common use as emetics.

Magendie doubts whether these movements are in any measure dependant upon nervous influence; but the fact of their being so seems to be proved by the experiments of Gmelin and Tiedemann, who found them constantly produced when the pneumogastric nerve was irritated either by the sealpel or by the contact of alcohol. Brachet, also, who examined the subject with great care, obtained similar results; and the only plausible argument against their conelusiveness consists in the double function whieh seems thus to be assigned to a single nerve—that of conveying to the brain a sense of the state of the stomach, and that of imparting motion to its muscular fibres. Brachet, however, turns this charge into an additional proof; for, on careful dissection, it appears that the pneumogastric nerve

* From *πνευμων*, *pneumon*, a lung, and *γαστηρ*, *gaster*, the stomach, or *lung and stomach* nerve

is really a compound of two distinct sets of fibres, intimately connected, no doubt, in structure and in function, but each essentially distinct in its origin, and so far fitted for a peculiar office.

When the pneumogastric or chief nerve of the stomach is tied or cut through, and its ends separated so as to interrupt the flow of nervous energy towards that organ, digestion is either entirely arrested or greatly impaired. By the greater number of physiologists this result is considered to arise from the consequent stoppage of that gentle and continued agitation of the alimentary mass in the stomach which is necessary for its thorough impregnation with the gastric juice, and which we have seen to depend on a stimulus communicated to its muscular coat by that nerve. By some, however, this explanation is regarded as incorrect. Magendie and Dr. Holland, for example, say that they have sometimes observed digestion continue even after the division of the nerve; and that, when it is retarded or impaired, the result arises only from the troubled state of respiration which the cutting of the nerve induces at the same time. To this, again, it is answered, that Dupuytren has divided the nerve below the part where the pulmonary branches are given off, and consequently left respiration unimpaired; but that still digestion was arrested, provided a portion of it was cut out so as not to allow the current of nervous influence to continue: for if the two ends of the nerve be left nearly in contact, it appears that little interruption of its action takes place.

Here, however, I cannot help observing, that, in drawing conclusions from experiments of this nature, the constitutional disturbance inseparable from the infliction of extensive wounds on living animals is seldom taken sufficiently into account. As regards digestion, for example, it is not to be expected that that function can be carried on with all the regular-

ity of health when the animal is suffering severe pain, even although the stomach be left untouched. Brachet indeed has shown, by direct experiment, that digestion may be interrupted almost as effectually by making an incision on the side or thigh (provided it be sufficiently deep and painful to excite constitutional disturbance), as by cutting the pneumogastric nerve itself. This being the case, we must not be too hasty in considering every apparent result as inseparably and exclusively connected with the individual injury under our notice at the time; we must repeat our observations under every variety of circumstances, and be careful to separate the accidental from the essential, before admitting the inference to be correct. It is, in fact, this unavoidable source of vagueness which so often renders experiments on living animals as inconclusive as they are inherently cruel.

But after making every allowance on this account, the experiments on digestion have been so frequently repeated, and so extensively varied, that the general results already noticed may safely be regarded as demonstrated. On all hands, accordingly, the necessity of the co-operation of the nervous energy in effecting it is admitted; for no one seriously denies the fact, that retardation or total cessation of digestion ensues, when the flow of the nervous fluid towards the stomach is prevented by the division and separation of the cut ends of the pneumogastric nerve, or by the operation of narcotics and the other disturbing causes already alluded to. It is true that the *mode* in which the nerve acts is not yet ascertained, although the fact of its necessary co-operation is rarely disputed. As, however, the direction of a current of galvanism to the cut end of the nerve next the stomach suffices to re-establish digestion after that process has been suspended by the interruption of the nervous influence consequent on its division, we may reasonably infer that, in the heal-

thy state, the nerve merely transmits to the stomach a stimulus or energy generated for the purpose either in the brain or in the spinal marrow and ganglia—that the nerve, in short, acts only as a conductor, and does not originate the influence which it evidently imparts. In several of Brachet's cases, indeed, as well as in those of Tiedemann, the continued irritation of the cut end of the nerve proved sufficient to carry on digestion to a certain point, by affording, in another way, the necessary stimulus to the muscular contractions of the stomach: for in all these experiments, digestion was found to have advanced almost in exact proportion to the degree of admixture which had been effected of the food with the gastric juice,—an admixture now ascertained to be produced chiefly by the contractile power of the stomach itself.

The muscular contractions of the stomach being thus under the guidance of the pneumogastric nerve, what are called its *vital* functions—those by which its life is sustained—viz., circulation, nutrition, secretion, and absorption, are generally considered to be carried on under the influence of the great *sympathetic* or *ganglionic* nerve, so called from its very extensive ramifications being supposed to bring the different parts of the system into relation with each other, and which, accordingly, is found to exist in animals that have neither brain nor spinal marrow, nor nerves of voluntary motion. In man, however, the sympathetic nerve receives filaments from the *sentient* or *feeling* part of the spinal marrow, probably for the purpose of connecting more intimately the organic with the higher functions of animal life. But as much obscurity still prevails on this subject, and moreover we have no direct control over the action of the ganglionic nerves, I shall not detain the reader with any conjectural discussion, but rather request his attention for a moment to the cir-

cumstance that it is through the medium of the nervous communications above hinted at, that the very remarkable influence which all must have experienced and observed as constantly exerted by the mind and stomach on each other, is kept up—an influence so powerful in its effects on both bodily and mental health, as to require special notice when we shall treat of the practical application of the present exposition.

The importance of the nervous agency in effecting digestion has been denied, because we are not *conscious* of the presence of food in the stomach. But in health the want of such consciousness is a privilege and not a defect; and it has been admirably pointed out by Dr. Southwood Smith,* that in possessing, as we do, the distinct consciousness of a *pleasurable* feeling in the stomach after indulging in a suitable meal, we have all that is desirable for either utility or enjoyment. If we were aware of the presence of every portion of food which the stomach contained, and of the changes occurring in each, our attention would be so disagreeably and unprofitably taken up that we would pray to be delivered from the annoyance. Where, however, from disease or the food being inappropriate, the stomach is injured by what is eaten, consciousness then becomes painful, for the express purpose of warning us that mischief has been done, and that we must take means for its removal.

The nerves of the stomach, it ought to be remarked, have a direct relation to *undigested food;* or, in other words, undigested food forms their natural and appropriate stimulus. In consequence of this arrangement, when any body incapable of digestion is introduced into its cavity, distinct uneasiness is speedily excited, and an effort is soon made to expel it either upwards by the mouth or down-

* Philosophy of Health, vol. i., p. 80

wards by the bowels. It is in this way that bile in the stomach excites nausea, and that tartar emetic produces vomiting. The nerves of the bowels, on the other hand, are constituted with relation to the presence of *digested food*, and consequently, when any thing escapes into them from the stomach in an undigested state, it becomes to them a source of irritative excitement; and hence the colicky pains and bowel-complaints which so commonly attend the passage of such undigestible substances as fat, husks of fruits, berries, and cherry-stones, through the intestinal canal.

Such, then, are the component parts of the stomach, and such the uses which they individually fulfil; but before we can consider them in their combined form, there is still another agent, and an important one, in digestion, which has already been repeatedly named, and which, though not a portion of the stomach, yet plays too conspicuous a part in its operations not to require some separate notice—the GASTRIC, OF STOMACH JUICE.

The existence of a solvent fluid in the stomach has long been known, and its uses suspected; but for our first accurate acquaintance with its properties and mode of action, we are indebted chiefly to the sagacity and persevering zeal of Spallanzani, who investigated the subject with great care and success about the middle of last century. Considering the peculiar difficulties by which the inquiry is surrounded, it is offering no trifling homage to that distinguished observer to say, that by means of numerous, varied, and well-devised experiments on man and animals, he succeeded in overcoming most of the obstacles which had baffled the ingenuity of his predecessors, and in obtaining results, the general accuracy and importance of which are now appreciated more and more highly, in proportion as our knowledge advances, and opportunities pre-

sent themselves of bringing them to the test of experience.

It is rarely, indeed, that we *can actually see* what is going on in a healthy stomach; but in a few instances this advantage has been enjoyed, and turned to account in investigating the phenomena of digestion. By far the most instructive example of this kind which has ever occurred, has lately come under the observation of Dr. Beaumont of the American army; and, as that gentleman eagerly embraced the opportunity so unexpectedly afforded him, of testing the prevailing doctrines by a series of experiments, continued during a period of several years, and under various conditions of health and external circumstances, I shall so frequently have occasion to refer to his observations, that it will be useful to give a brief outline of the case before entering farther upon the subject, in order that the reader may be enabled to judge for himself what weight is due to Dr. Beaumont's evidence on any disputed point.

Dr. Beaumont, while stationed at Michilimackinac, in the Michigan territory, in 1822, in the military service of the United States, was called upon to take charge of ALEXIS ST. MARTIN, a young Canadian of eighteen years of age, good constitution, and robust health, who was accidentally wounded by the discharge of a musket on 6th June, 1822.

"The charge," says Dr. Beaumont, "consisting of powder and duck-shot, was received in the left side, at the distance of one yard from the muzzle of the gun. The contents entered posteriorly, and in an oblique direction, forward and inward; literally blowing off integuments and muscles to the size of a man's hand, fracturing and carrying away the *anterior half of the sixth rib, fracturing the fifth, lacerating the lower portion of the left lobe of the lungs, the diaphragm, and* PERFORATING THE STOMACH."

On the fifth day, sloughing took place; lacerated portions of the lung and stomach separated, and left a perforation into the latter " large enough to admit the whole length of the middle finger into its cavity; and also a passage into the chest half as large as his fist." Violent fever and farther sloughing ensued; and for seventeen days every thing swallowed passed out through the wound, and the patient was kept alive chiefly by nourishing injections. By-and-by the fever subsided, the wound improved in appearance, and after the fourth week the appetite became good, digestion regular, the evacuations natural, and the health of the system

complete. *The orifice, however, never closed;* and at every dressing the contents of the stomach flowed out, and its coats frequently became everted or protruded so far as to equal in size a hen's egg, but they were always easily returned. The above figure

exhibits the appearance of the wound after it was healed. The circumference of the wound EEEL, extended to about twelve inches ; and the opening into the stomach AAA, nearly in its centre, was about two inches below the left nipple F. The folds of the villous coat are visible at BC.

Some months after, St. Martin suffered extremely from the death and exfoliation of portions of the injured ribs and their cartilages, and his life was often in jeopardy ; but, through the skill and unremitting care with which he was treated by Dr. Beaumont, he ultimately recovered, and in April, 1823, was going about, doing light work, and rapidly regaining strength.

On 6th June, 1823, a year from the date of the accident, the injured parts were all sound except the perforation into the stomach, which was now two and a half inches in circumference. For some months thereafter the food could be retained only by constantly wearing a compress and bandage ; but early in winter, a small fold or doubling of the villous coat began to appear, which gradually increased till it filled the aperture, and acted as *a valve*, so as completely to prevent any efflux from within, but to admit of being easily pushed back by the finger from without.

Here, then, was an admirable opportunity for experimenting on the subject of digestion, and for observing the healthy and undisturbed operations of nature free from the agony of vivisections, and from the sources of fallacy inseparable from operating on animals. Dr. Beaumont was sensible of its value, and accordingly pursued his inquiries with a zeal, perseverance, and disinterestedness highly creditable to his character both as a man and as a philosopher. Having been fortunate enough to obtain a copy of his work, I shall not hesitate to make free use of its contents.

Dr. Beaumont began his experiments in May,

1825, and continued them for four or five months, St. Martin being then in high health. In the autumn, St. Martin returned to Canada, married, had a family, worked hard, engaged as a voyageur with the Hudson's Bay Fur Company, remained there four years, and was then engaged at a great expense by Dr. Beaumont to come and reside near him on the Mississippi, for the purpose of enabling him to complete his investigations. He came accordingly in August, 1829, and remained till March, 1831. He then went a second time to Canada, but returned to Dr. Beaumont in November, 1832, when the experiments were once more resumed, and continued till March, 1833, at which time he finally left Dr. Beaumont. He now enjoys perfect health, but the orifice made by the wound remains in the same state as in 1824.

Dr. Beaumont describes the aperture in St. Martin's stomach as being situated about three inches to the left of the cardia, near the left superior termination of the great curvature. When the stomach was nearly empty, he was able to examine its cavity to the depth of five or six inches by artificial distention. When it was entirely empty, the stomach was always contracted on itself, and the valve generally forced through the orifice, together with a portion of the mucous membrane equal in bulk to a hen's egg. After sleeping for a few hours on the left side, the protruded portion became so much larger as to spread "over the neighbouring integuments five or six inches in circumference, fairly exhibiting the natural *rugæ*, villous membrane, and mucous coat, lining the gastric cavity. This appearance is almost invariably exhibited in the morning before rising from bed." Such was the very favourable subject on whom Dr. Beaumont's observations and experiments were made, and such were the numerous opportunities which he enjoyed for repeating them, and verifying their accuracy. Hav-

ing given this outline, we now return to the consideration of the gastric juice, on the origin and qualities of which it throws much light.

In treating of the properties of the gastric juice, I shall on all disputed points give a decided preference to the observations of Dr. Beaumont over those of any other physiologist; because, although a few cases have occurred, in which, from external wounds, direct access has been given to the interior of the stomach, and Richerand and others have availed themselves of the opportunities thus afforded of adding to our knowledge of the digestive process, still, in most of them which have been recorded, the patients were a comparatively short time under observation, and were not sufficiently re-established in health to admit of either extensive or conclusive experiments being made. Whereas, in the case which Dr. Beaumont had the good fortune to meet with, the patient remained under his eye for several years, and in the enjoyment of the most robust health; so that ample time and opportunity were afforded for every variety of experiments which reflection could suggest, and for their subsequent repetition under such modifications as seemed to be requisite for clearly distinguishing the accidental from the constant and essential result. In addition to these reasons, it ought to be added, in justice to the American physiologist, that, from the excellent judgment with which he carried on his investigations, and the scrupulous care with which he announces his results and separates facts from theory, it is impossible not to place great confidence both in his personal qualifications as an observer, and in the general accuracy of his statements. Moreover, as he enjoyed the rare advantage of *seeing* what he describes to have taken place in the stomach during healthy digestion, his evidence comes before us with the strongest possible claims on our attention.

The first disputed point which is conclusively

settled by Dr. Beaumont is, that *the gastric juice does not continue to be secreted between the intervals of digestion, and does not accumulate to be ready for acting upon the next meal.* By inducing St. Martin to fast for some hours, and then placing him with the opening in the left side exposed to a strong light, so as to give a distinct view of the cavity of the stomach, Dr. Beaumont found its only contents to consist of a little viscid and occasionally slightly acidulated mucus mixed with saliva, and in no instance did he perceive any accumulation of the proper gastric juice. The same results had indeed been obtained by Tiedemann and other physiologists before the publication of Dr. Beaumont's memoir; but the evidence of the latter is so much more direct and incontrovertible, that it may justly be regarded as setting the question for ever at rest.

Having proceeded so far, Dr. Beaumont next endeavoured to discover at what time the gastric juice begins to be poured out, and under what conditions its secretion is carried on; and here again ocular inspection afforded him satisfactory results.

It has already been remarked, that, on pushing back the valve which filled up the opening into the stomach, the cavity within became visible to a considerable extent; and that when St. Martin lay over for a time on the left side, a portion of the villous coat, large enough to exhibit several inches of its surface, generally protruded. Owing to these circumstances, Dr. Beaumont could easily observe what changes occurred, both when food was swallowed in the usual way, and when it was introduced at the opening left by the wound. Accordingly, on examining the surface of the villous coat with a magnifying-glass, he perceived an immediate change of appearance ensue whenever any aliment was brought into contact with it. The action of the neighbouring bloodvessels was instantly increased, and their branches dilated so as to admit

the red blood much more freely than before. The colour of the membrane consequently changed from a pale pink to a deeper red, the vermicular or *worm-like* motions of the stomach became excited, and innumerable minute lucid points and very fine nervous and vascular papillæ could be seen arising from the villous coat, from which distilled a pure, colourless, and slightly viscid fluid, which collected in drops on the very points of the papillæ, and trickled down the sides of the stomach till it mingled with the food. This afterward proved to be the secretion peculiar to that organ, or, in other words, the true *gastric juice;* the mucous fluid secreted by the follicles, which some have mistaken for it, is not only more viscid, but wants altogether the acid character by which it is generally distinguished.

Pursuing his experiments, Dr. Beaumont then found that the contact, not only of food, but of any mechanical irritant, such as the bulb of a thermometer, or other indigestible body, invariably gave rise to the exudation of the gastric fluid from these vascular papillæ; but that, in the latter cases, the secretion always ceased in a short time, as soon apparently as the organ could ascertain that the foreign body was one over which the gastric juice had no power. But the small quantity obtainable in this way is perhaps more pure and free from admixture, and therefore better adapted for examination, than any which can be procured under any other circumstances.

Various methods have been employed for procuring the gastric fluid in a state of purity. Pieces of dry sponge, enclosed in a dry, hollow, perforated ball, with a string attached to it, have been swallowed both by man and by inferior animals, and afterward withdrawn to have the juice expressed from them. In some instances the stomachs of criminals and animals killed after fasting have been opened, and the secretion collected. At other times the juice has been procured by voluntary or artificial vomit-

ing. None of these methods is equal to that employed by Dr. Beaumont; but of the three the first is unquestionably the best, because, although no gastric juice previously exists, the very contact of the ball excites the secretion of a quantity sufficient to moisten the sponge. In the second mode of proceeding, any portion of juice secreted in consequence of a stimulus applied *after* the stomach is opened, must necessarily be very small, and rendered impure by the large admixture of mucus which it will contain; while, by the third method, either no gastric juice but merely mucus will be procured, or it will be expelled mixed with the food which had previously elicited its secretion.

Gastric juice, in its purest form, and unmixed with any thing except the small portion of mucus from which it can never be obtained entirely free, is described by Dr. Beaumont to be a clear transparent fluid, without smell, slightly saltish (probably from the admixture of mucus), and very perceptibly acid. Its taste, he says, resembles that of thin mucilaginous water, slightly acidulated with muriatic acid. It is readily diffusible in water, wine, or spirits, and effervesces slightly with alkalis—a direct proof of its acid nature. It coagulates albumen, and is powerfully antiseptic, checking the progress of putrefaction in meat. When pure, it will keep for many months; but when diluted with saliva, it becomes fetid in a few days. According to Professor Dunglison, to whom some was submitted by Dr. Beaumont for analysis, it contains free *muriatic* and *acetic* acids,—*phosphates* and *muriates* with bases of *potassa*, *soda*, *magnesia*, and *lime*,—together with an animal matter soluble in cold, but insoluble in hot water. Tiedemann and Gmelin, again, describe it as composed principally of *muriatic* and *acetic* acids, mucus, saliva, *osmazome*, *muriate* and *sulphate of soda*, with little or no albumen; and, according to the same physiologists, the proportion of acid is always greatest when vegetables or other substances

of difficult digestion constitute the chief part of the diet. Other chymists give an analysis somewhat different from either of these; a circumstance which was indeed to be expected, considering not only the differences caused by variations of diet, but also the necessarily different degrees of purity of the fluid submitted to examination.

The most remarkable property of the gastric juice is unquestionably the power which it possesses of dissolving and reducing to the appearance of a soft, thickish fluid mass every thing in the shape of food which is submitted to its action,—while it exerts no perceptible influence on living or inorganic matter; for, so far as is yet known, nothing which is not organized, or which is still alive, can serve as nutriment for the animal frame. Water is the only inorganic body which is taken into the system for its own sake, and all mineral and other inorganic productions enter it as component parts of previously organized substances of either an animal or a vegetable nature. To a great extent, indeed, vegetation seems to be merely a process for the conversion of inorganic matter into a proper nutriment for the support of animal life; and many species of animals seem in their turn to be little else than living machines for the conversion of vegetable substances into a nutriment fit for other species by which they are intended to be devoured. It is true that, in some parts of South America, the natives, pressed by want, consume quantities of a soft unctuous clay, which is of course destitute of organization; but as there is every reason to believe that no nourishment is derived from it, and that it merely serves to allay the pangs of hunger, such instances form no exception to the general rule.

It would have been easy for the Creator to bestow such a structure on all animals, as to make them subsist entirely on vegetable aliment. But the arrangement which he has seen fit to adopt, is

the source of an infinitely greater amount of active enjoyment than what could otherwise have existed. Had there been no beasts of prey, the world would soon have been overrun with herbivorous creatures to such an extent, that their numbers would speedily have become excessive in reference to the possible supply of food, and there would have been infinitely more suffering from starvation and disease, than what actually arises out of their existing relation to each other. On the present plan, there is ample food and onjoyment for all; and when the time does arrive when one animal must become the prey of another, the deprivation of life is in most cases unforeseen, and the suffering which attends it is in general only momentary in duration. There is thus both complete enjoyment of life while it lasts, and a great additional field opened for the support of an immense class of animals, which, with their present constitution, could not otherwise have existed at all.

The gastric juice, as already remarked, has no power over living animal matter—a most wise and admirable provision, since otherwise it would at once have attacked and destroyed the very organ which produces it. This is the reason why worms are able to exist in the stomach of man and other animals; so that, if it were possible for an oyster swallowed directly from the shell to continue to live, it would effectually resist every attempt at digestion. But it, in common with most other beings, cannot sustain life under such circumstanees; and as soon as it dies, the gastric juice assumes the mastery, and speedily converts it into chyme.

If any thing could have opened Montègre's eyes to the fallacy under which he laboured in considering the gastric juice as almost identical with saliva, the circumstance we are now to mention would have sufficed. When a person, previously in good health, dies by a violent death, or when an animal is killed soon after a meal, it very often happens

that, on opening the body after an interval of some hours, the stomach is found to be eroded, and its contents poured into the cavity of the abdomen, precisely as if a hole had been formed in it by ulceration. It was long before the reason of this was discovered; but at length it was ascertained to arise from *the action of gastric juice* (*the abundant secretion of which was provoked by the immediately preceding meal*) *upon the substance of the stomach, now subjected to its power from being deprived of life.* This fact has been so often verified, that it is by all admitted as incontrovertibly true. If, therefore, the gastric juice be merely saliva and mucus, we might expect to find after death some traces of similar results from the contact of saliva with the mouth or gullet; but *there* no such erosion is ever witnessed, nor, as Montègre himself admits, does saliva exert any solvent power whatever over dead animal matter out of the body. These facts appear quite sufficient to convince any unprejudiced mind.

The power of *coagulating* milk, and albumen or the white of eggs, is another remarkable property of the gastric juice,—and one so familiarly known, that in dairies an infusion of the stomach of the calf is in common use, under the name of runnet or rennet, for curdling milk. In infants, also, we know that the nurse's milk has scarcely reached the stomach before coagulation takes place; a fact which leads many inexperienced mothers to infer that the infant is already suffering from acidity, and to counteract the supposed evil by repeated doses of magnesia—which, of course, do more harm than good. The coagulation of milk in the stomach is so far from being a morbid process, that milk cannot be properly digested without it. By the separation and absorption of the fluid whey, the curd is reduced to a proper consistence for being acted upon, both by the gastric juice itself and by the contractions of the muscular coat.

The gastric juice is also powerfully *antiseptic;* that is to say, it prevents animal substances from becoming putrid, and even renders sweet such as have advanced a considerable way towards putrefaction. Dr. Beaumont mentions that the pure juice will keep unchanged for almost any length of time; and, according to Spallanzani, meat may be preserved in it without taint for five or six weeks, or even longer. This antiseptic tendency of the gastric fluid accounts for the circumstance that little or no mischief results from the common practice among epicures, of not making use of game till the putrefactive process is advanced farther than is agreeable to the palates of the uninitiated.

The qualities of the gastric juice are so directly adapted to the natural food of the animal, that flesh introduced into the stomach of an ox or a sheep, for example, undergoes scarcely any change; while vegetable food, on the other hand, remains equally undigested in that of a beast of prey. Thus, "when a hawk or an owl has swallowed a small bird, in the stomach of which have been seeds, these bodies are not dissolved by the gastric fluid,"* but pass through the intestines unaltered. Man, the dog, and some other creatures, possess the power of digesting all sorts of aliment, whether vegetable or animal, and are hence called omnivorous; but even in them, the relation which the properties of the gastric juice bear to the qualities of the food chiefly or exclusively used is so close, that, when a widely different kind is suddenly resorted to, indigestion is the almost inevitable consequence, because then the gastric juice has not had time to acquire its requisite adaptation to the new materials on which it has to act.

Even in its chymical constitution, the gastric juice of carnivorous animals differs from that of the herbivorous; a circumstance which accounts for the

* Macgillivray's Description of the Rapacious Birds of Great Britain, p. 24

difference of effect. In the former, such as that of birds of prey, serpents, and fishes, no free or uncombined acid can be detected, although it is invariably found in the gastric fluid of vegetable-eaters. In crows and dogs, on the other hand, and such animals as can live on either kind of aliment, it is never acid except when they have been fed *chiefly* on grain or plants. In man, the same relation has, by numerous experiments, been ascertained to exist.

But although, in every class of living beings, the gastric juice is constituted with a direct relation to its natural food, still its qualities may be so much modified by a very gradual change of diet, as to fit it for digesting aliment of a very dissimilar or opposite kind. Thus, in the natural state, the stomach of a sheep exerts scarcely any action on beef or mutton; but if the change from the one kind of food to the other be made by slow degrees, the gastric juice will in the end become so essentially altered as to enable it to digest them. In this way, as is mentioned by Delabere Blaine, a horse at the Veterinary College was supported for some time by animal matter alone; while others have subsisted on dried fish or on milk.* It has been shown, also, by John Hunter, Spallanzani, and others, that eagles, falcons, owls, pigeons, and domestic fowls, may for a time be fed on aliments altogether foreign to their natural habits. But these facts only show the extent to which nature will go, on an emergency, for the preservation of life; and no more indicate the equal fitness of both kinds of aliment, than the fact of some men being able to stand for a few minutes on their heads proves an inverted position to be the natural attitude of the human race.

In consequence of this adaptation of the gastric juice to the nature of the food, it is obvious that *sudden and extreme changes from one kind of diet to*

* Blaine's Veterinary Art, 3d edit. p., 274.

another must be injurious, because the stomach has not time to modify its secretions sufficiently to meet the altered demand made upon its powers. This, accordingly, is one of the reasons why so much caution is used in bringing horses into condition after having been for some time in the pasture-field. When they have previously been on dry food in the straw-yard, corn may be given with greater safety; so that it is the change, not so much in quantity as in *kind* of aliment, which causes the risk. And, on this account, when a horse is to be put upon hard food, after having been fed on grass or other succulent vegetables, Blaine recommends, not only that hay and corn should be given in very small quantities at first, but that the hay should be moistened, and the corn *mixed with bran and mashed*; by which means, having acquired a greater analogy to grass, it will be more easily acted upon by the gastric juice, which has been previously adapted for green food.

Even in man, the gastric juice undergoes considerable modifications, not merely according to the kind of aliment habitually used, but also according to the wants of the system, the season of the year, and the state of the health; so that, while sudden and great changes from one kind of diet to another are positively hurtful on the one hand, absolute uniformity is not less objectionable on the other.

Many attempts have been made to ascertain to which of the elements of the gastric juice its power is chiefly to be ascribed, and experiments have been instituted on them individually to discover which of them is most nearly analogous to it in effect. From the general results, it appears that acetic acid (vinegar) and muriatic acid have a wider range of influence, and produce solvent effects more closely resembling those of gastric juice, than any other known substances. Both of these acids, it will be recollected, are constituent elements of the gastric fluid; and it has, in consequence, been argued, that to them it is

indebted for all its energy. And, indeed, without laying too much stress on this real or supposed analogy, it is impossible to overlook the well-known fact, that scurvy, and a highly alkaline state of the system, are generally induced by a diet restricted for a long time to animal food alone, and are prevented or cured most easily by a free use of lemon-juice or of vegetable matter, either fresh or fermented. In these circumstances, the vegetable acid is probably efficacious both by directly improving digestion, and by combining with the excess of the alkaline salts already existing in the system. It is worthy of remark, too, that in weak stomachs *acidity* is almost invariably induced by the use of vegetable food, possibly to some extent for the very purpose of effecting its digestion; for it has been ascertained beyond a doubt, that in herbivorous animals the gastric juice always contains some free or uncombined acid—and in man also, after living much on vegetables for some time.

The necessity of acid for the chymification of vegetable food, affords an explanation of the fondness which the Germans and Dutch display for *saurkraut*—or cabbage in a state of acetous fermentation—and of its alleged easy digestibility. It explains, also, the general use of vinegar along with salads, cucumbers, oysters, salmon, and other substances of difficult digestion, and shows that its utility is not imaginary, but loudly proclaimed by nature's own acts.

Another important principle, which Dr. Beaumont conceives to be established by his numerous experiments, and which forced itself upon him by degrees, is, that in health THE GASTRIC SECRETION ALWAYS BEARS A DIRECT RELATION TO THE QUANTITY OF ALIMENT NATURALLY REQUIRED BY THE SYSTEM; so that, if more than this be taken, there will necessarily be too small a supply of the juice for the digestion of the whole. The principle here laid down

is in perfect harmony with the sympathy which we have seen to exist between the stomach and the rest of the body, and therefore not only is highly probable in itself, but, if sound, will prove a most valuable guide in the practical regula ion of diet. The number of phenomena which it explains, and its general applicability to daily use, afford no small presumption of its truth. When, for example, we eat more than the wants of the system require, indigestion will follow, because there will be more food in the stomach than what the quantity of gastric juice provided is able to dissolve; the proportion of the juice secreted being in relation, not to what we eat, but to the actual wants of the system, which, in the case supposed, we have greatly exceeded. Here a remarkable harmony will be perceived between the quantity of the secretion and the true indications and uses of appetite as a guide to diet, explained in a preceding chapter (p. 35).

The gastric secretion, and the appearance of the villous coat, undergo great modifications during disease, and on this subject also Dr. Beaumont's observations are highly valuable; because, instead of merely inferring, as others are obliged to do, he enjoyed the privilege of SEEING with his eyes what was actually going on. In the course of his attendance on St. Martin, he found that, whenever a feverish state was induced, whether from obstructed perspiration, from undue excitement by stimulating liquors, from overloading the stomach, or from fear, anger, or other mental emotion depressing or disturbing the nervous system, *the villous coat became sometimes red and dry, and at other times pale and moist, and lost altogether its smooth and healthy appearance.* As a necessary consequence, the usual secretions became vitiated, impaired, or entirely suppressed; and the follicles from which, in health, the mucus which protects the tender surface of the villous coat is poured out, became flat and flaccid,

and no longer yielded their usual bland secretion. The nervous and vascular papillæ, thus deprived of their defensive shield, were then subjected to undue irritation. When these diseased appearances were considerable, the system sympathized, and dryness of the mouth, thirst, quickened pulse, and other symptoms, showed themselves; and NO GASTRIC JUICE COULD BE PROCURED OR EXTRACTED EVEN ON THE APPLICATION OF THE USUAL STIMULUS OF FOOD.

These facts, if correctly observed, are of extreme importance; and from the care with which Dr. Beaumont pursued his investigations, I do not think their general accuracy can be called in question. The dry, irritated appearance of the villous coat, and the absence of the healthy gastric secretion in the febrile state, not only explain at once the want of appetite, nausea, and uneasiness generally felt in the region of the stomach, but show the folly of attempting to sustain strength by forcing the patient to eat when food cannot be digested, and when nature instinctively refuses to receive it.

Before dismissing this part of the subject, it may be remarked, that the alleged sympathy of the stomach with the wants of the body has been denied, because the sense of hunger disappears the moment food is swallowed, or the stomach is distended even with clay or sawdust, although the actual wants of the system cannot by possibility have been supplied in either case. But these facts seem to me rather to justify the inference that a sympathy does exist. Hunger ceases when *food* is taken, simply because *now* the condition of the stomach is in the desired relation to the state of the body, and the nerves consequently feel and transmit this impression to the more distant parts. In the other case, again, it ceases because the stomach cannot at first distinguish what is food from what is not; and therefore, when distended, expresses con-

tent, because it feels satisfied that it has been honestly dealt with, and got what it wanted. But whenever it discovers the cheat, which it does in no long time, hunger returns, and can be properly appeased only by digestible substances. Dr. Beaumont indeed expressly mentions, that, although the gastric secretion *commences* the moment any indigestible body touches the mucous surface of the stomach, it invariably *ceases* soon after discovering that the substance is one over which it has no power—thus strongly confirming the existence of the sympathy.

CHAPTER V.

THEORY AND LAWS OF DIGESTION.

Different theories of Digestion.—Concoction.—Fermentation.—Putrefaction.—Trituration.—Chymical solution.—Conditions or laws of digestion.—Influence of gastric juice.—Experiments illustrative of its solvent power.—Its mode of action on different kinds of aliment—beef, milk, eggs, soups, &c.—Influence of temperature.—Heat of about 100° essential to digestion.—Gentle and continued agitation necessary.—Action of stomach in admitting food.—Uses of its muscular motion.—Gastric juice acts not only on the surface of the mass, but on every particle which it touches.—Digestibility of different kinds of food.—Table of results.—Animal food most digestible.—Farinaceous next.—Vegetables and soups least digestible.—Organs of digestion simple in proportion to concentration of nutriment.—Digestibility depends on adaptation of food to gastric juice more than on analogy of composition.—Illustrations.—No increase of temperature during digestion.—Dr. Beaumont's summary of inferences.

Before entering upon the consideration of the theory of digestion which naturally evolves itself from the facts expounded in the preceding chapter, it may be of advantage to turn for a moment to the

various theories which have prevailed since the subject first attracted the attention of the learned.

Hippocrates regarded digestion as a kind of *concoction*, or *stewing;* and many of his followers believed that it is effected in the stomach by the agency of heat alone, much in the same way as food is cooked over a fire. It is quite ascertained that heat favours the process, but it is pure absurdity to maintain that that agent alone will accomplish digestion.

Others of the older physiologists contended that chymification results from simple *fermentation* of the alimentary mass, and referred to the gas disengaged during difficult digestion, as a proof that the process of fermentation was going on. But it is now demonstrated that the tendency of healthy digestion is rather to arrest than to induce fermentation, and that the latter takes place only when disease exists, or when more food has been swallowed than the quantity of gastric juice secreted by the stomach is able to dissolve. Moreover, the products of digestion and of fermentation are so extremely different, that it is impossible to believe them to originate from the same chymical action.

The next theory which prevailed considered digestion to be the result of the *putrefactive* process. The single fact that the gastric juice not only arrests putrefaction, but even restores to sweetness meat in which that process is begun, is sufficient to demonstrate the wildness of such a supposition.

Another set of physiologists imagined that *trituration* would account best for all the changes occurring in the food during digestion; and consequently regarded the chyme as a sort of emulsion formed by the intimate mixture of the aliment with the juices of the stomach, just as an emulsion is formed by rubbing down almonds in a mortar. The advocates of this theory referred for proofs not only to the contractile motions of the stomach already noticed, but to the muscular apparatus for tritura-

tion which forms so remarkable a feature in the gizzard of granivorous birds. But, in adopting this conclusion, they forgot that in birds the triturating apparatus does not digest, but serves, like the organs of mastication in man and quadrupeds, merely to bruise the grain on which the animal lives. In birds, in fact, digestion *begins* only after the trituration is finished.

A more recent and much more accurate view of digestion is that which considers it as neither more nor less than a *chymical solution* of the food in the gastric juice. This theory is supported by a greater number of facts and experiments than any other; but, although substantially correct, it is, perhaps, too exclusive and limited in its principles. It is true, that by the agency of gastric juice on food out of the body, a change very similar to chymification can be effected on it; but when we remember that *chyme*, or the *result* of real digestion, is essentially the same in its elementary or component principles, whatever be the kind of food from which it is formed, and that as yet we are acquainted with no purely chymical agent which, applied to different substances, gives rise to the same uniform product, we shall be more willing to believe that chymification is neither a purely mechanical nor a purely chymical operation; but the result of a vital process, to which both mechanical and chymical forces contribute, and which no action or combination of inanimate matter can either exactly imitate or supersede.

To enable ourselves to appreciate correctly the nature of digestion, we must begin by considering the conditions essential for its performance, or without which it cannot be carried on.

The FIRST indispensable requisite is an *adequate supply of gastric juice*, and its *thorough admixture with every particle of the food* on which it is to operate. The SECOND is *a steady temperature of about* 98° *or* 100° *Fahr.*; and the THIRD is *the gentle and*

continued agitation of the alimentary mass in the stomach while digestion is going on.

In illustration of the influence of the FIRST condition, I may refer to the experiments already mentioned as having been made by Spallanzani, Stevens, and others, to show the solvent power of the gastric juice on food even out of the body. Spallanzani states, that when small portions of well-masticated beef or mutton are placed in a vial, with a due proportion of gastric juice, and the requisite temperature and gentle agitation are secured by placing the vial in the armpit, the appearances presented at the end of a few hours are extremely analogous to those observed in the natural process of chymification; the meat being in both cases converted into the soft grayish mass of a pultaceous consistence called chyme.

Dr. Beaumont, who was well aware of the importance of Spallanzani's researches, and of the almost universal adoption of his views by succeeding physiologists, till confidence in their accuracy was for a time shaken by the bold and fallacious assertions of Montègre, felt that the opportunity afforded him by St. Martin's wound for verifying or disproving the experiments on which these views were founded, was much too valuable to be lost. He therefore entered upon a long series of investigations, of which the following is an imperfect, though, I hope, instructive abstract.

To test the reality of the solvent powers ascribed to the gastric juice, Dr. Beaumont withdrew from St. Martin's stomach about one ounce of it, obtained after a seventeen hours fast, by introducing first a thermometer to induce the secretion, and then a gum-elastic tube to carry it off. Into this quantity, placed in a vial, he introduced a piece of *boiled recently-salted beef*, weighing three drachms. He then corked the vial tightly, and immersed it in water raised to the temperature of 100°, which he

had previously ascertained to be the heat of the stomach when the secretion was going on. In *forty minutes*, digestion had distinctly commenced on the surface of the beef. In *fifty minutes*, the fluid became quite opaque and cloudy, and the texture of the beef began to loosen and separate. In *sixty minutes*, chyme began to be formed. In *one hour and a half*, the muscular fibres hung loose and unconnected, and floated about in shreds. In *three hours*, they had diminished about one half. In *five hours*, only a few remained undissolved. In *seven hours*, the muscular texture was no longer apparent; and in *nine hours*, the solution was completed.

To compare the progress of digestion in the natural way with these results, Dr. Beaumont, at the time of commencing the experiment just described, suspended a piece of the same beef, of equal weight and size, within the stomach, by means of a string. At the end of the *first half hour* it presented the same appearances as the piece in the vial; but when Dr. Beaumont drew out the string at the end of an *hour and a half*, the beef had been completely digested and disappeared, making a difference of result in point of time of nearly seven hours. In both, the solution began on the surface, and agitation accelerated its progress by removing the external coating of chyme as fast as it was formed. When the experiment was repeated with chicken instead of beef, the solution was slower, from the greater compactness of the chicken not allowing the gastric fluid to penetrate its substance so readily. Had the beef and chicken been masticated before being subjected to experiment, the difference between them in the rapidity of digestion would probably have been less.

To ascertain still more accurately the difference between *natural* and *artificial* digestion (the one *in* and the other *out of* the stomach), Dr. Beaumont put

twelve drachms of *recently-salted boiled beef* into a vial, with the same number of drachms of fresh gastric juice obtained through the opening of the stomach after a fast of eighteen hours; and then placed it in a basin of water on a sand-bath, where he kept it at the heat of 100° Fahr., and continued to agitate it gently. Digestion soon commenced, and progressed uniformly for about six hours, when it ceased. One half of the meat was then dissolved, and the texture of the remainder loosened and tender—resembling the same kind of aliment when ejected from the stomach partly digested some hours after a meal, as frequently seen in cases of indigestion. On weighing the undissolved portion which remained after all action had ceased, six drachms and twelve grains of the beef were found to have been digested by twelve drachms, or nearly double its weight, of gastric juice. It thus appears that a given quantity of gastric fluid can digest only a relative proportion of meat; so that, when more is eaten than what there is juice sufficient to dissolve, stomachic disorder must necessarily follow. In this latter case, Dr. Beaumont found that the addition of fresh juice causes digestion to be resumed.

To discover what influence would be exerted on food masticated, swallowed, and mixed with the gastric juice in the usual way, and then withdrawn from the stomach, Dr. Beaumont gave St. Martin an ordinary dinner of *boiled salted beef*, *bread*, *potatoes, and turnips*, with a gill of pure water for drink; and twenty minutes afterward drew off through the opening about a gill of the contents of the stomach into an open-mouthed vial. In this short space of time digestion had already commenced, thus negativing the common notion that an hour elapses before it begins. The vial was now placed in a water-bath, at a temperature of 100°, and continued there for five hours. Examined at the end of that time, the whole contents were found to be dissolved.

On then extracting an equal quantity of chyme from the stomach, and comparing it with the solution in the vial, little difference was observable between them, except that the process had been somewhat more rapid in than out of the stomach. But this experiment is remarkable in another point of view, as showing that in the short space of twenty minutes enough of gastric juice had been secreted for the entire completion of digestion.

With a view to verify these results, and also to discover the comparative digestibility of different kinds of aliment, Dr. Beaumont gave St. Martin for dinner eight ounces of *recently-salted lean beef*, four ounces of *potatoes*, some *bread*, and four ounces of boiled *turnips*. After fifteen minutes he withdrew a portion of the contents of the stomach, and found that some of the meat had already been slightly digested. In a second portion, withdrawn at the end of forty-five minutes, fragments of the beef and bread were perceptible, and in a still more advanced state of digestion; the meat was in small shreds, soft and pulpy, and the fluid containing it had become more opaque and gruel-like in appearance. When two hours had elapsed, a third quantity was taken out, at which time nearly all the meat had become chymified and changed into a reddish-brown fluid; but *small pieces of vegetable matter now presented themselves for the first time, but in a state of digestion so much less advanced* than the meat, that their peculiar structure was still distinctly visible. Some of the second and third portions, put into a vial and treated in the usual way, advanced to complete digestion, as in the other experiment, except that the process was slower, and that a few vegetable fibres remained to the last undissolved; thus confirming the general opinion, that vegetables are more difficult of digestion than animal substances.

The *mode* of solution by the gastric juice varies according to the nature of the food on which it acts.

We have seen that it gradually reduces solids to a soft and fluid state; but its effect on milk and albumen is different. It begins by *coagulating* them, so as to give them the requisite consistence for being affected by the muscular contractions of the stomach, and impregnated with the juice. Fifteen minutes after St. Martin had drunk half a pint of milk, a portion taken out of the stomach by Dr. Beaumont presented the appearance of a fine, loosely-coagulated substance, mixed with a semi-transparent whey-coloured fluid. A drachm of warm gastric juice, poured into two drachms of milk, at a temperature of 100°, produced a precisely similar appearance in twenty minutes. In another experiment, when four ounces of bread were given along with a pint of milk, and the contents were examined at the end of thirty minutes, the milk was coagulated, and the bread reduced to a soft pulp floating in a large proportion of fluid. In two hours the whole was completely digested.

When the *white* or *albumen* of two eggs was swallowed on an empty stomach, small white flakes began to be seen in about ten or fifteen minutes, and the mixture soon assumed an opaque whitish appearance. In an hour and a half the whole had disappeared. Two drachms of albumen, mixed with two of gastric juice out of the stomach, underwent the same changes, but in a rather longer time.

When the food is chiefly *liquid*, as when soup is taken either alone or in large proportion, the more fluid part is speedily absorbed, to fit the remaining nutritious portion for being better acted on by the gastric juice and muscular power of the stomach. Fifty minutes after St. Martin had dined on vegetable soup, beef, and bread, Dr. Beaumont found the stomach to contain a pulpous mass, like thick gruel in consistence, and of a semi-gelatinous aspect. The fluid portion had been absorbed to such an

extent, that the remainder was even thicker than is usual after eating more solid food. From many similar observations, Dr. Beaumont infers it to be a general law, that soup and liquids cannot be digested until they are formed into a thicker mass by the absorption of their watery part—as till then they are too liquid to be easily acted on by the gastric juice. Hence their unfitness for weak stomachs, and the impropriety of large libations of tea or coffee at breakfast by persons whose digestion is bad. During recovery from illness, chicken-tea, beef-tea, and soups are often useful, simply because the system then requires the liquid to make up its lost blood.

Unfortunately, Dr. Beaumont made few experiments on the action of gastric juice upon vegetables; and, in the few recorded, he generally contents himself with noting the length of time required for their solution, which generally proved considerably longer than for animal substances. In one experiment, however, he states, that an hour after giving St. Martin nine ounces of *raw*, *ripe*, *sour apples*, the stomach was full of fluid and pulp, "quite acrid, and irritating the edges of the aperture, *as is always the case when he eats acescent fruits or vegetables*." In an hour and a half the contents were still more sharp and acrid, and the pulp of the apple visible. At the end of two hours the stomach was empty, but the mucous membrane exhibited an irritated appearance. With farinaceous vegetables, however, the results were different. Thus, when a pint of thick, rich, boiled sago, sweetened with sugar, was given, the whole was digested in less than two hours, and there was neither acrimony of the gastric contents, nor smarting of the edges of the wound: on the contrary, it seemed peculiarly grateful to the stomach, and rendered the mucous membrane soft, uniform, and healthy. The same results followed a repetition of the experiment, and also

when a pint of soft custard was taken. In some states of the stomach, it is true, even farinaceous food excites acrimony and irritation, but rarely in the same degree as the other forms of vegetable aliment.

Such being the influence of gastric juice on different aliments at the natural heat of the body, we have now to ascertain, in the SECOND place, what share the *high temperature* has in the result.

To determine this point, Dr. Beaumont took out two ounces of gastric juice, and divided it into two equal portions, in separate vials. He added to each an equal weight of masticated fresh beef; and placed the one in a bath, at the temperature of 99°, and the other in the open air, at 34°. As a contrast to these, he placed beside the latter a third vial, containing the same weight of masticated meat in an ounce of clear water.

In two hours the meat in the warm vial was partially digested; that in the cold gastric juice was scarcely changed; and the third portion, in the cold water, seemed only a little macerated. In six hours the meat in the warm vial was half digested, while that in the two others had undergone no farther alteration. The gastric juice in the first vial having by this time dissolved as much as it could of the beef, four drachms more were added from the stomach, and the vial was replaced in the bath. *Digestion, which had previously ceased, was now resumed, and went on as steadily as if it had not been interrupted;* thus showing, in a striking manner, the impropriety of exceeding in our meals the quantity for which alone a sufficiency of gastric juice can be provided.

At the end of twenty-four hours, the three portions were examined. That contained in the warm juice was completely dissolved, and presented the usual appearances. The portions contained in the

cold juice and in the cold water very much resembled each other, and exhibited no appearance of chyme whatever. They were macerated or softened, but not digested. These experiments, and others of a similar nature, show clearly that a temperature equal to ordinary blood-heat is requisite for chymification.

To make sure that it was the low temperature alone which prevented the occurrence of digestion in the experiment detailed, Dr. Beaumont now placed the vial containing the meat which had been exposed without effect for twenty-four hours to the action of the cold gastric juice, on a water-bath at the ordinary blood-heat. In a very short time "digestion commenced, and advanced regularly as in the other parcels." The same results were always obtained from a repetition of these experiments, so that they may be held as perfectly conclusive in establishing the essentiality of heat to the digestive process.

Thirdly.—The necessity of *gentle* and *continued agitation* for the accomplishment of digestion is so obvious from the preceding exposition, that it requires no direct experiments to establish it. When portions of meat were suspended in the stomach, by a string so short as to prevent them from being fully subjected to the motion already described as always going on during digestion, the action of the gastric juice was confined almost entirely to their surface, and a longer time was consequently required for their solution than when they were left at liberty. In like manner, when meat out of the stomach was placed in a vial containing gastric juice, its solution was uniformly accelerated by gentle agitation, which acted simply by removing the coating of chyme as it formed on the surface, and thus affording to the gastric fluid an easier access to the undigested portions below. Accordingly, when, in one of Dr. Beaumont's experiments, two ounces of unmasticated

roasted beef were introduced through the external aperture into the stomach, and held by a string, only one half of it was digested in four hours, evidently from the want of mastication confining the action of the gastric juice to the surface of the mass, and because the string prevented it from following the regular motions of the stomach.

Having now made the reader sufficiently acquainted with the agents concerned in, and the conditions essential to, the performance of digestion out of the body, we have next to exhibit the same agents and the same conditions in their ordinary operation in the living being, and to describe the beautiful arrangements by which they are respectively and unerringly regulated.

It has been already shown, that, in endowing us with appetite, nature has intended both to ensure by its means a timely provision for the wants of the system, and to guard against our eating more than enough to supply them. We have also seen that, within certain limits, the quantity of gastric juice secreted bears a direct relation to the quantity of food consumed; that when the food exceeds considerably the real necessities of the system, a part of it remains undigested, because the stomach is unable to secrete a sufficiency of fluid for the solution of the whole; and that, as a necessary consequence, indigestion follows. This being the case, we may expect to find all the arrangements of nature made with a view to prevent us from hastily filling the stomach to repletion, without being fully warned beforehand of the error we are committing. And such accordingly is the fact.

Considered in this light, the processes of mastication, insalivation, and deglutition, are not only useful in preparing the morsel for the future action of the gastric juice, but, by transmitting the food to the stomach in small portions at a time, likewise

serve the important secondary purpose of *preventing its too rapid or excessive distention.* To this good end, indeed, the stomach itself contributes, as has been distinctly shown by Dr. Beaumont. In the natural state of that organ, a regular and gentle contraction of its whole fibres and cavity follows the introduction of each individual morsel, and it is not till the relaxation consequent on that contraction takes place, that another is willingly admitted. This arrangement was more than suspected by other physiologists, but it remained for the American experimenter to *demonstrate* its existence and purposes. It is true that, during a hurried repast for example, food *may* be rapidly introduced into the stomach by an active effort of the will, but it is precisely in such circumstances that we are apt to eat too much, and that indigestion follows; because, from no time being allowed for the secretion of the requisite quantity of gastric juice, and its proper mixture with each portion of the aliment, the stomach is placed in an unnatural situation, and its nerves cannot receive the same impression of "*enough eaten*," which is designed by nature to arise only from the one being duly proportioned to and mixed with the other. The advantage of the natural arrangement is therefore confirmed rather than refuted by what may at first appear an exception.

When Dr. Beaumont depressed the valve in St. Martin's stomach, and introduced a few spoonfuls of soup at the orifice, he observed the rugæ or folds of the mucous membrane to close gently upon it, gradually diffusing it through the gastric cavity, and completely preventing the entrance of a second quantity till this diffusion was effected—when relaxation again took place, and admitted of a farther supply. When solid food was introduced in the same way, either in larger pieces or finely divided, the same gentle contraction and grasping motion

were excited, and continued from fifty to eighty seconds, so as to prevent more from being introduced without considerable force till the contraction was at an end. When St. Martin was so placed as to admit of the cardia or upper orifice of the stomach being brought into view, and he was then made to swallow a morsel of food in the natural way, a similar contraction of the stomach, and closing of its fibres upon the bolus, was invariably observed to take place; and till this was over, a second morsel could not be received without a considerable effort. And accordingly, when, either from haste or hunger, we disregard the order of nature, and hurriedly gulp down food without due mastication, and without allowing time for the regular contraction of the stomach, we necessarily expose ourselves to the risk both of overloading it, and of ultimately impairing its digestive power.

Such being the provision made for ensuring the gradual admission of food into the stomach, the next requisite is *its proper admixture with the gastric juice.*

Food being the appropriate stimulus of the secreting vessels of the stomach, the moment the alimentary morsel comes into contact with the mucous membrane, the action of the latter, as was formerly pointed out, becomes increased; its blood-vessels are distended, its colour deepens to a brighter red, and the gastric juice immediately begins to be poured out. The muscular fibres of the stomach, being acted upon by the same stimulus, next come into play, and execute their specific functions of alternate contraction and relaxation. By these means the aliment speedily becomes impregnated with the gastric fluid, and undergoes the influence of that continued gentle agitation already described as essential to digestion, and which seems to have for its chief object the careful admixture of every portion of the nutriment with the quantity

of gastric juice necessary for its solution. The particles of food are thus continually changing place, and if the quantity taken be not too great for the power of the gastric juice which the stomach can supply, chymification goes on equally throughout; so that, if the contents of the stomach be withdrawn in from thirty minutes to an hour after a moderate meal, they will be found to consist of perfectly formed chyme and particles of food, intimately mixed and blended, in larger or smaller proportions, according to the vigorous or enfeebled state of the digestive organs, and the quality of the aliment itself. So effectually indeed has the admixture of food and solvent juice taken place in this short time, that, as already shown, when a portion is removed from the stomach and placed in an appropriate vessel, digestion will commonly continue in it, provided it be placed in a proper temperature, and subjected to gentle and continued agitation.

It is the impossibility of its being adequately acted upon by the muscular contractions of the stomach, which renders fluid and highly concentrated nourishment, when exclusively used, so difficult of digestion; and hence the reason why a certain bulk and consistence given to whale oil, for example, by the admixture of such innutritious substances as vegetable fibre, bran, or even sawdust, make it a more acceptable and digestible article of food to the inhabitants of the northern regions, than when it is consumed in its pure state. In like manner, in civilized society, bread, potatoes, and vegetables are useful, not less by giving the requisite bulk and consistence to the rest of the food, than by the nutriment which they contain. Soups, jellies, arrowroot, and similar substances, are, for the same reason, more easily digested when eaten along with bread or some bulkier aliment, than when taken alone, especially if used for some time.

The motion which we have seen to be excited in the stomach by the entrance of aliment, is at first very gentle and slight; but in proportion as digestion proceeds, or the organ is distended, it becomes more rapid and energetic; and then it serves the additional purpose of gradually propelling the chyme through the pylorus into the intestine, there to be farther prepared and converted into chyle. The necessary churning or agitation of the food is, from the peculiar situation of the stomach, greatly assisted by the play of the diaphragm and abdominal muscles during inspiration and expiration; and the diminution of the vivacity and extent of the respiratory movement which always attends despondency and grief, is one source of the enfeebled digestion which notoriously accompanies or follows depression of mind. The same cause also leads necessarily to an unfavourable condition of the blood itself, which in its turn weakens digestion in common with every other function; but the muscular or mechanical influence is that which at present chiefly concerns us. On the other hand, the active and energetic respiration attendant on cheerfulness and buoyancy of spirits adds to the power of digestion, both by aiding the motions of the stomach, and by imparting to it a more richly constituted blood. If to these causes be added the increase of nervous stimulus which pleasing emotions occasion in the stomach (as in the muscles, and organs of secretion generally), we shall have no difficulty in perceiving why digestion goes on so well in parties where there is much jocularity and mirth. "Laughter," says Professor Hufeland of Berlin, "is one of the greatest helps to digestion with which I am acquainted; and the custom prevalent among our forefathers, of exciting it at table by jesters and buffoons, was founded on true medical principles. In a word, endeavour to have cheerful and merry companions at your meals: what

nourishment one receives amid mirth and jollity will certainly produce good and light blood."*

Exposed to the action of all the agents above enumerated, and to the increased nervous and vascular excitement which are necessary during digestion, a singular change soon commences in the food, and goes on till chymification is completed. After a little while the contents of the stomach, whatever their nature and variety, begin to be converted into a substance of a homogeneous, soft, grayish, and viscid appearance, of a sweetish, *fade*, and slightly acid taste, but which still preserves some of the qualities of the food, and is called chyme. The chyme always forms on that part of the food with which the gastric juice is in immediate contact; and, in proportion as it is produced, it is carried gradually onwards by the gentle motion of the stomach towards the pylorus, where consequently it always exists in the greatest quantity. At the cardiac or left end of the stomach it is most sparingly found, both because digestion is there only beginning, and because the chyme is speedily removed from it and carried away towards the pylorus.

The doctrine hitherto generally received, and held by Dr. Wilson Philip and others as demonstrated, is, that "the layer of food lying next to the surface of the stomach is first digested, and in proportion as this undergoes the proper change, and is moved by the muscular action of the stomach, that next in turn succeeds, to undergo the same change." Dr. Beaumont however declares, that, whatever may be the case in rabbits and other animals on which Dr. Philip's experiments were made, such was not the order observed in the stomach of Alexis St. Martin,—and such, he naturally infers, is not the order in the human stomach in general. Nor is such, I

* Art of Prolonging Human Life, English edition. London, 1829, p. 282.

may add, the order which either experience or a correct view of the antecedent circumstances and physiological conditions ought to lead us to anticipate. When vomiting, for instance, occurs an hour or two after a meal composed of different ingredients has been swallowed, no such separation into digested and undigested portions is to be found, but the whole are observed to have undergone changes proportioned to their degrees of digestibility, whether they were eaten first or last.

In conformity with this view, Dr. Beaumont mentions, that when St. Martin swallowed a mouthful of any tenacious food after the digestion of the preceding meal was considerably advanced, he always saw it first pass towards the great curvature of the stomach and then disappear. In a minute or two it reappeared, more or less broken down, and *mixed with the general alimentary mass;* and in a short time longer it was so much changed as entirely to lose its identity. From these and numerous other facts, Dr. Beaumont infers, that "there is a perfect admixture of the whole ingestæ during the period of alimentation and chymification;" and that "the whole contents of the stomach, until chymification be nearly complete, exhibit a heterogeneous mass of solids and fluids—hard and soft, coarse and fine, crude and chymified—all intimately mixed, and circulating promiscuously through the gastric cavity, like the mixed contents of a close vessel, gently agitated or turned in the hand."—(P. 112.) As we proceed we shall meet with various indirect proofs of these statements being correct.

If Dr. Beaumont's observations on this subject are accurate, we may expect to find that chymification commences *on the surface of each individual fragment* of the food, and is not confined to the outer surface of the entire alimentary mass, as stated by Dr. Philip. Such, accordingly, is the fact. When Dr. Beaumont extracted a portion of the food

through the opening half an hour or an hour after eating, he invariably found it composed of perfectly formed chyme and particles of food intimately mixed and blended; and in these experiments every portion of the aliment was already so completely supplied with gastric juice, that its chymification proceeded till the whole was digested with no other aid than that of the requisite heat and agitation.

When a meal is taken before the preceding one is out of the stomach, digestion is observed to be disturbed. Dr. Wilson Philip explains this by stating, that the newly-swallowed food becomes imbedded in, and occupies the centre of, the older and half-digested mass, where it remains distinct and untouched till the former meal is entirely disposed of. A more logical explanation, however, and one more in harmony with facts, is offered by Dr. Beaumont, who ascribes the disturbed digestion to *the supply of gastric juice having been entirely taken up by the first meal*, and to the stomach, now comparatively exhausted, being unable to secrete a fresh supply for the second—seeing that, in ordinary circumstances, its vessels secrete only enough to meet the real wants of the system. Dr. Beaumont adduces, in confirmation of this view, the fact that many children, and most cooks, are in the habit of eating *small* quantities of food almost every hour or two without their digestion suffering materially, because then the amount of gastric juice secreted is quite equal to the chymification of the *whole* quantity taken.

Reasonable as this inference appears from the facts stated by Dr. Beaumont, I cannot help thinking that there is something more in the constitution of the stomach than the mere deficiency of gastric juice, which renders the too early intrusion of new food hurtful. We know, for example, that at the commencement of digestion, the muscular contractions of the stomach are comparatively slow and

feeble, and that, as chymification advances, they become rapid and energetic, as if to remove the chyme as fast as it is formed. If, then, new food, for which the feebler movement is best adapted, be introduced when digestion is far advanced, and the energetic motion going on, may not this disproportion be itself an impediment, and co-operate with the deficiency of the gastric juice in disordering digestion? Moreover, as the stomach, in common with every other organ intended for alternate activity and repose, is always more or less fatigued by the active fulfilment of its function, its premature excitement by new food must add to its exhaustion, and weaken its power (in the same way in which fresh muscular exertion adds to the exhaustion of muscles already sufficiently exercised), and consequently lead to imperfect digestion.

The same principle which explains the necessity of repose for repairing the vascular and nervous energy of the stomach, when these have been excited and exhausted by the labour of digestion, also affords a solution of the question why the appetite does not return as soon as the stomach is empty, but begins to be felt only after the stomach has enjoyed a period of repose, varying in duration with the mode of life, the state of health, and the nature of the previous meal.

If we regard chymification as going on at the surface of every individual portion of the food which has been sufficiently supplied with gastric juice, we at once see that the constant motion of the stomach is necessary, 1st, to remove the chyme from the surface of each little fragment of the alimentary mass; and, 2dly, by this very removal to expose a fresh surface of the fragment to the contact of the mucous membrane, thereby enabling it to excite such farther secretion of gastric juice as may be required to complete its digestion. In this way the formation and removal of chyme go on from the very

first, although it is then necessarily produced and removed more slowly than after the gastric solvent has had time to act. It is generally said that an hour elapses before any chyme is formed; but Dr. Beaumont has detected its existence at a much earlier period, and is of opinion that, from the uniform and constant decrease in the contents of the stomach, which begins as soon as the food is swallowed, chymification commences almost immediately. This decrease, though slow at first, becomes gradually accelerated, till the whole mass is converted into chyme. Apparently in harmony with this more energetic action, the acidity of the gastric fluid also becomes greater, and affords a greater stimulus, in proportion as digestion advances.

As formerly explained, the thickish, semi-fluid, grayish chyme, into which the aliment is converted, is gradually impelled towards the pyloric extremity of the stomach, in proportion as it is formed. On its arrival there, the pylorus, or valve between the stomach and the intestine called the *duodenum*, opens and allows the chyme to pass into the intestine. But, by a curious mode of sensibility, if any portion of undigested food be mixed with it, the pylorus contracts upon it, refuses it egress, and throws it back into the stomach for farther digestion.

If, however, any thing really indigestible finds its way into the stomach, and presents itself at the pylorus—or if the stomach has temporarily lost its digestive power, and the food remains in it for many hours unchanged—then the pylorus, after repeatedly refusing egress, at last opens and allows it to pass into the gut. So marked is the contractile impulse towards the pylorus when digestion is going on, that Dr. Beaumont found even the bulb of his thermometer carried down with a steady and considerable force.

Such are the *direct* conditions requisite for the fulfilment of digestion: but there remain others, of

an *indirect* kind, which also require to be noticed. Of these, a due supply of arterial blood and nervous energy is the most remarkable; but as both produce their effect by modifying the secretions and motions of the stomach, already described as the *direct* requisites of digestion, it will save a good deal of repetition if, for the present, we take their influence for granted, and reserve their further elucidation till we come to treat of the practical applications of the preceding exposition.

Having thus obtained a comprehensive view of the agents employed in effecting digestion, and of the changes produced by it on different kinds of food, we find another important subject of investigation, immediately connected with the process, presenting itself—*the comparative digestibility of different kinds of food.* Dr. Beaumont did not neglect this branch of the inquiry; but the experiments which he performed for its elucidation are, like those of most of his predecessors, deprived of great part of their value by the vague way in which they seem to have been conducted, and the common omission of all particulars in regard to those conditions which are known to exert a powerful influence on the progress of digestion.

The following table exhibits the general results of all the experiments made upon St. Martin posterior to 1825; and the average is deduced from those which were performed when the stomach was considered by Dr. Beaumont to be in its natural state, and St. Martin himself subjected to ordinary exercise.

TABLE showing the Mean Time of Digestion of the different Articles of Diet.

Articles of Diet.	Mode of Preparation.	Time required for Digestion. H. M.
Rice	Boiled	1
Sago	Do.	1 45
Tapioca	Do.	2
Barley	Do.	2
Milk	Do	2
Ditto	Raw	2 15
Gelatine	Boiled	2 30
Pigs' feet, soused	Do.	1
Tripe, soused	Do.	1
Brains	Do.	1 45
Venison steak	Broiled	1 35
Spinal marrow	Boiled	2 40
Turkey, domestic	Roasted	2 30
Do. do.	Boiled	2 25
Do. wild	Roasted	2 18
Goose	Do.	2 30
Pig, sucking	Do.	2 30
Liver, beef's, fresh	Broiled	2
Lamb, fresh	Do.	2 30
Chicken, full-grown	Fricassee	2 45
Eggs, fresh	Hard boiled	3 30
Do. do.	Soft do.	3
Do. do.	Fried	3 30
Do. do.	Roasted	2 15
Do. do.	Raw	2
Do. whipped	Do.	1 30
Custard	Baked	2 45
Codfish, cured, dry	Boiled	2
Trout, Salmon, fresh	Do.	1 30
Do. do.	Fried	1 30
Bass, striped, fresh	Broiled	3
Flounder do.	Fried	3 30
Catfish do.	Do.	3 30
Salmon, salted	Boiled	4

TABLE showing Mean Time of Digestion, *continued.*

Articles of Diet.	Mode of Preparation.	Time required for Digestion. H. M.
Oysters, fresh	Raw	2 55
Do. do.	Roasted	3 15
Do. do.	Stewed	3 30
Beef, fresh, lean, rare	Roasted	3
Do. do. dry	Do.	3 30
Do. steak	Broiled	3
Do. with salt only	Boiled	2 45
Do. with mustard, &c.	Do.	3 30
Do. fresh, lean	Fried	4
Do. old, hard, salted	Boiled	4 15
Pork-steak	Broiled	3 15
Pork, fat and lean	Roasted	5 15
Do. recently salted	Boiled	4 30
Do. do.	Fried	4 15
Do. do.	Broiled	3 15
Do. do.	Raw	3
Do. do.	Stewed	3
Mutton, fresh	Roasted	3 15
Do. do.	Broiled	3
Do. do.	Boiled	3
Veal, fresh	Broiled	4
Do. do.	Fried	4 30
Fowls, domestic	Boiled	4
Do. do.	Roasted	4
Ducks, do.	Do.	4
Do. wild	Do.	4 30
Suet, beef, fresh	Boiled	5 3
Suet, mutton	Do.	4 30
Butter	Melted	3 30
Cheese, old, strong	Raw	3 30
Soup, beef, vegetables, and bread	Boiled	4
Do. marrow-bones	Do.	4 15
Do. beans	Do.	3
Do. barley	Do.	1 30
Do. mutton	Do.	3 30
Green corn and beans	Do.	3 45

TABLE showing Mean Time of Digestion, *continued.*

Articles of Diet.	Mode of Preparation.	Time required for Digestion. H. M.
Chicken soup	Boiled	3
Oyster soup	Do.	3 30
Hash, meat and vegetables	Warmed	2 30
Sausage, fresh	Broiled	3 20
Heart, animal	Fried	4
Tendon	Boiled	5 30
Cartilage	Do.	4 15
Aponeurosis	Do.	3
Beans, pod	Do.	2 30
Bread, wheaten, fresh	Baked	3 30
Do. corn	Do.	3 15
Cake, do.	Do.	3
Do. sponge	Do.	2 30
Dumpling, apple	Boiled	3
Apples, sour and hard	Raw	2 50
Do. do. mellow	Do.	2
Do. sweet do.	Do.	1 30
Parsnips	Boiled	2 30
Carrot, orange	Do.	3 15
Beet	Do.	3 45
Turnips, flat	Do	3 30
Potatoes, Irish	Do.	3 30
Do. do.	Roasted	2 30
Do. do.	Baked	2 30
Cabbage, head	Raw	2 30
Do. with vinegar	Do.	2
Do. do.	Boiled	4 30

This table is very interesting, but the results must not be too much relied upon, or regarded as representing the *uniform* rate of digestibility. We have already seen that chymification is greatly influenced by the interval which has elapsed since the preceding meal, the amount of exercise taken, the keenness of the appetite, the state of the health and mind, the completeness of the mastication, the state of rest or exercise after eating, and various other

circumstances; and, above all, *the quantity swallowed in proportion to the gastric juice secreted.* And consequently, if an experiment be made without regard to these conditions, and without any thing being recorded except the time occupied in digestion in the individual case, the conclusions deduced from it may be most fallacious. The very aliment which, taken in full quantity, remains on the stomach for hours, may, in a smaller quantity, be entirely digested in one third of the time. Thus, in the foregoing table, two and a half hours are set down as the average time required for the chymification of jelly, but in the 41st experiment, we find that eight ounces of that substance were entirely digested in ONE hour. So that, if all the other conditions are not carefully kept in view at each trial, the results cannot possibly be held as conclusive.

It may be said that, on the day of the 41st experiment, St. Martin's digestion must have been particularly good—and, in truth, it seems to have been so: for at 9 o'clock A. M. he breakfasted on *soused tripe*, *pig's feet*, *bread*, and *coffee*, and yet, only *one* hour later, no vestige of any of these savoury things remained in the stomach. What renders this result the more remarkable is the fact, that, in another table at page 45, a simple breakfast of coffee and bread is set down as having required FOUR hours for its digestion. The rapid disposal of the same elements, with the addition of soused tripe and pig's feet, instead of disproving my position, evidently strengthens it, by showing that, if *from any cause* the digesting power varies in intensity, the result obtained from the experiment on one kind of food cannot, with any show of reason, be considered as an accurate index to its rate of digestibility in comparison with that of other kinds.

This neglect of the other conditions is accordingly the circumstance which throws a doubt over the results not only of Dr. Beaumont's experiments, but

of those of every other inquirer. Dr. Beaumont indeed candidly admits, that his were performed for the purpose of demonstrating other important principles connected with digestion, and not at all with the view of determining the comparative rates of digestibility of different kinds of aliment; and in alluding to the various requisites for a satisfactory series of experiments, he himself justly states, that this would be an Herculean task, which it would take years to accomplish. In considering the following general results, then, the reader ought to bear in mind that they are only probable and approximative, and not strictly demonstrated or certain.

As a general rule, animal food is more easily and speedily digested, and contains a greater quantity of nutriment in a given bulk, than either herbaceous or farinaceous food; but, apparently from the same cause, it is also more heating and stimulating. *Minuteness of division*, and *tenderness of fibre*, are shown by Dr. Beaumont's experiments to be two grand essentials for the easy digestion of butcher-meat; and the different kinds of fish, flesh, fowl, and game, are found to vary in digestibility chiefly in proportion as they approach or depart from these two standard qualities.

Farinaceous food, such as rice, sago, arrow-root, and gruel, are also rapidly assimilated, and prove less stimulating to the system than concentrated animal food. Milk seems to rank in the same class, when the stomach is in a healthy state.

The other kinds of vegetable substance are the slowest of all in undergoing digestion, and very frequently pass out of the stomach and through the bowels comparatively little changed; and hence the uneasiness which their presence so often excites in the bowels, especially in persons of weak digestion, owing to the nerves of the intestines having a relation to *digested* food. In a given bulk they contain

less nutriment, and excite the system less, than any other kind of food; so that they are well adapted for the diet of those in whom it is necessary to avoid every kind of stimulus, and who are not subjected to great muscular exertion: but to a person undergoing hard labour, they afford inadequate support.

Liquids—soup, for example—are slow of digestion, and hence are unfit for most dyspeptic patients. Before the gastric juice can act upon them, the fluid part must be absorbed, and the mass thickened to a proper consistence for undergoing the usual *churning* motion. On examining the contents of the stomach an hour after St. Martin had dined on beef-soup, Dr. Beaumont found that the absorption of the watery part had been carried so far as to leave the remainder of even a thicker consistence than after an ordinary solid meal. When drink is swallowed, it is carried off in the same way by absorption, and is not digested or allowed to pass through the pylorus. One purpose of this provision seems to be to prevent the gastric juice from being rendered inefficient by too much dilution.

When the food on which an animal lives is of a highly concentrated kind, and contains much nourishment in a small bulk, the apparatus of organs provided for its digestion is on a correspondingly small scale in point of extent. Thus, in carnivorous animals, whose food is, bulk for bulk, the most nutritious of all, the stomach and intestines are simple and short, the latter not exceeding in length more than from one to four or five times that of the body. In herbivorous animals, on the other hand, whose food is sparingly nutritious, and therefore requires to have a large bulk or volume, the stomach, as we saw in a former chapter, is greatly more complicated, and the length of the intestines enormously increased. Man, being intended to feed on both animal and vegetable substances, possesses an organization which holds an intermediate place betwee

the two extremes. In him, neither are the intestines so short as in carnivorous animals, nor have they the complexity and length characteristic of the herbivorous—thus clearly showing the intentions of nature in regard to his food, and at the same time allowing him a considerable latitude of adaptation when the force of circumstances for a time denies him access to any variety.

Animal food being in general more quickly digested than vegetable, and a simpler organization being sufficient for its conversion into chyme, many physiologists have inferred that this was owing to its being already of an animal nature, and therefore requiring scarcely any change to fit it for becoming a constituent part of the living fibre. But I agree with Dr. Beaumont in thinking that this explanation is more gratuitous than philosophical, and that the process of chymification implies almost as complete a change in the one instance as in the other. In both, the operation of the gastric juice seems to be entirely analogous. In both, a complete solution takes place, and the chyle into which animal food is ultimately converted bears no greater resemblance to the future animal fibre, than does that produced from vegetable aliment. Thus, the chyle of a horse, which lives exclusively on vegetables, has quite as great a resemblance to its future muscle, as that of a tiger, a lion, or a fox has to *its* future produce. Besides, whether the food be animal or vegetable, the ultimate result of digestion is always the formation of *new animal matter;* but in the former case, the nutritive particles are mixed up with a smaller proportion of innutritious matter than in the latter, and consequently a larger quantity of them can be extracted from a given bulk in a shorter time than in the case of vegetables. There are most probably also minute differences in the chymical composition of the chyle derived from different kinds of food; but its general nature—its fitness for form-

ing new animal tissue—and that of the process by which it is produced, are always the same.

Animal food, it is true, affords a more stimulating nutriment than farinaceous and other kinds of vegetable aliment, and hence it is avoided in diseases of excitement. But it seems to me that this stimulus is owing not only to its own inherent properties, but also to its more highly concentrated state, and to the much greater quantity of chyle which is derived from it than from an equal bulk of vegetable aliment. From the numerous experiments of injecting water, poisons, and other substances into the veins, performed by Magendie and others, we have direct proofs that the same agent which, introduced rapidly into the system, will sometimes act so powerfully as to destroy life, will excite scarcely any perceptible disorder if introduced very slowly. Analogy, therefore, bears us out in believing that the rapid admixture of very nutritious chyle with the blood may over-stimulate the system, when its more gradual introduction would have produced no such effect. At the same time, there can be no doubt that there is also a greater inherent stimulus in animal than in vegetable aliment.

It seems to be partly for the purpose of obviating the evil of the too rapid introduction of nutriment, and partly for that of varying the stimulus, that nature has rendered a certain bulk of food advantageous to digestion, and decreed that no animal can long retain its health if fed on highly concentrated aliment alone. Dogs fed on oil or sugar, which are almost wholly converted into chyle, become diseased and die in a few weeks; and, as Dr. Paris has acutely remarked, the very capacity of our digestive organs is a proof that nature never intended them for the exclusive reception of highly concentrated food. Dr. Paris refers to post-horses fed chiefly on beans and corn, as instances among the lower animals of the insalubrity of too condensed nutriment,

and shows that they live constantly on the brink of active disease, and every now and then require bleeding, laxatives, and emollients, to keep them in condition. Sportsmen, boxers, and others, who train themselves for severe exertion, are additional examples showing that a similar mode of living induces a morbid tension of the system which cannot be long kept up without danger. The Kamtschatdales sometimes live with impunity for months on fish-oil, by wisely mixing it up with sawdust or other indigestible vegetable fibre.

If the preceding explanation of the more rapid digestion of animal than of vegetable substances, and the higher stimulus which they afford, be correct, the common notion, of the former being more digestible than the latter *solely* because there is a greater analogy between animal food and the system which it goes to nourish, and therefore a smaller change to be undergone, necessarily falls to the ground. If it be true—which it seems to be—that, *in the natural state*, in a temperate climate, animal food is more easily digested than vegetable, the fair inference ought rather to be that the system requires the former in larger proportion than the latter, and that the gastric juice is purposely constituted with reference to this circumstance. Accordingly, in the arctic regions, where the climate renders great stimulus necessary, animal food, of to us the most indigestible kind—that consisting of pure fat and oil—is eaten in immense quantities, and digested with enviable facility; while in India and other tropical climates, where much less stimulus is required, the natives digest vegetable aliment with at least equal ease and satisfaction.

If, as Dr. Paris imagines, animal food owes its digestibility simply to its possessing "a composition analogous to that of the structure which it is designed to supply," and therefore requiring "little more than division and depuration," instead of the

alleged "complicated series of decompositions and recompositions which must be effected before vegetable matter can be animalized or assimilated to the body,"*—it follows that butcher-meat must in all climates and situations be more digestible than vegetables; and that *raw* meat, which has the greatest analogy of all to the structure of the body, must require still less digestive power for its solution and assimilation than cooked meat. These propositions, however, are wholly at variance with experience: in particular, the effect of cooking is unquestionably to induce a change of composition subversive of the analogy on which Dr. Paris rests his opinion.

That the easier digestibility of animal food in man arises chiefly from its greater adaptation to the qualities of the gastric juice, and not from any such analogy as that now alluded to, is rendered still more probable by the fact, that in him the gastric fluid contains scarcely any free acid, except where the diet has consisted for some time principally of vegetables; whereas it always contains a considerable proportion of acid in herbivorous creatures. In the latter, moreover, the analogy is quite as great between animal substances and their own structure as in man, and yet to a cow, beef is much more indigestible than grass, notwithstanding the "decompositions and recompositions" which the latter is supposed to require before becoming animalized. Dr. Beaumont is therefore quite justified in maintaining, that the process of digestion implies as complete a solution and recomposition in the case of animal as of vegetable substances; and that the rapidity with which the chymification of either is effected *depends more on its adaptation to the properties of the gastric juice provided by nature for its solution, than on the closeness of resemblance of its own composition to that of the body of which it is to become a part.*

* Paris on Diet, p. 93.

Another prevalent notion—that the digestive apparatus is simpler and shorter in carnivorous than in herbivorous animals, merely because their food is more analogous in composition to their own bodies, and therefore requires less perfect digestion—seems to me equally unfounded, and to be negatived by the fact, that in the grain-eating birds, in the constituent elements of whose food there is no such analogy, the intestines nevertheless scarcely exceed in length those of carnivorous birds—a circumstance at variance with the notion of length being necessary *solely* on account of the great elaboration required for the conversion of vegetable into animal substance. The true principle—and it is important to notice it, as the error is generally adopted—appears to be, that *where the food of the animal contains much nutriment in a small bulk, there the stomach and intestinal canal are simple and short*; but where, on the contrary, it contains little nutriment in a large bulk, there great capacity, complexity, and length become requisite to enable the animal to elaborate a sufficiency of nourishment for its subsistence, by taking in the requisite quantity from which it is to be derived. Accordingly, in the elephant and some other herbivorous animals, we find the capacity to depend not on the length, but on the width and increased surface of the intestine, or, in other words, on the greater calibre of its cavity; whereas, in some fishes which live on very concentrated aliment, the intestinal canal is not much more than the length of the body—thus showing that the common opinion on the subject is utterly untenable.

Before concluding his experiments on the agents employed in digestion, Dr. Beaumont made many observations with a view to ascertain whether any increase of temperature occurred during that process. By introducing a thermometer with a long stem at the external opening into St. Martin's stom-

ach, both before and during chymification, he succeeded in obtaining very accurate information on this point. In two or three of the experiments the heat of the stomach seemed to be increased after taking food, but in by far the greater number the temperature remained the same. It appeared, however, that the variations of the atmosphere produced a sensible change on the heat of the stomach—a dry air increasing and a moist air diminishing it. The ordinary temperature may be estimated at 100° Fahr., and in several instances it was higher at the pyloric than at the cardiac end. On one cloudy, damp, and rainy day, the thermometer rose only to 94°, and on another to 96°; whereas next day, when the weather was clear and dry, it rose to 99°, and on that following, when the weather was both clear and cold, to 100°. On several occasions it rose as high as 102°, and once to 103°; but these were after exercise, which was always observed to cause an increase of two or three degrees. We have already seen that *artificial* digestion is entirely arrested by cold, and is resumed on raising the temperature to ordinary blood heat.

Such, then, are the phenomena and conditions of healthy digestion, and such is the light thrown upon them both by the valuable publication of the American physiologist. Before leaving this branch of the subject, however, it may be useful to lay before the reader, as a kind of summary, the principal inferences deduced by Dr. Beaumont from his numerous experiments and observations. But in doing so, I shall attempt to arrange the results in their natural order; for in the original work they are given without reference either to logical sequence or to time.

INFERENCES FROM DR. BEAUMONT'S EXPERIMENTS AND OBSERVATIONS.*

1. That *hunger* is the effect of *distention* of the vessels that secrete the gastric juice.
2. That the process of *mastication*, *insalivation*, and *deglutition*, in an abstract point of view, do not in any way affect the digestion of the food; or, in other words, when food is introduced directly into the stomach in a finely divided state, without these previous steps, it is as readily and as perfectly digested as when they have been taken.
3. That *saliva* does not possess the properties of an alimentary solvent.
4. That the *agent* of chymification is the *gastric juice.*
5. That the pure gastric juice is fluid, *clear, and transparent;* without *odour;* a little salt; and perceptibly *acid.*
6. That it contains free *muriatic acid*, and some other active *chymical* principles.
7. That it is never found *free* in the gastric cavity; but is always excited to discharge itself by the introduction of *food* or other irritants.
8. That it is secreted from vessels distinct from the mucous follicles.
9. That it is seldom obtained pure, but is generally mixed with mucus, and sometimes with saliva. When pure, it is capable of being kept for months, and perhaps for years.
10. That it *coagulates* albumen, and afterward *dissolves* the *coagulæ.*
11. That it *checks* the progress of putrefaction.
12. That it acts as a *solvent* of food, and alters its properties.
13. That, like other chymical agents, it *commences*

* The inferences are given in Dr. Beaumont's own words, and the italics also are his.

its action on food as soon as it comes in contact with it.

14. That it is capable of combining with a certain and fixed *quantity* of food, and when more aliment is presented for its action than it will dissolve, disturbance of the stomach, or "indigestion," will ensue.
15. That its action is facilitated by the *warmth* and *motions* of the stomach.
16. That it becomes intimately *mixed* and *blended* with the ingestæ in the stomach by the motions of that organ.
17. That it is *invariably* the *same substance*, modified only by *admixture* with other fluids.
18. That the motions of the stomach produce a constant *churning* of its contents, and *admixture* of food and gastric juice.
19. That these motions are in two directions, *transversely* and *longitudinally*.
20. That *no other* fluid produces the same effect on food that gastric juice does; and that it is the *only solvent of aliment*.
21. That the action of the stomach and its fluids is the same on *all kinds* of diet.
22. That *solid* food, of a certain texture, is easier of digestion than *fluid*.
23. That *animal* and *farinaceous* aliments are more easy of digestion than *vegetable*.
24. That the susceptibility of digestion does not, however, depend altogether upon *natural* or *chymical* distinctions.
25. That digestion is facilitated by *minuteness of division* and *tenderness of fibre;* and retarded by opposite qualities.
26. That the *ultimate principles* of aliment are always the same, from whatever food they may be obtained.
27. That *chyme* is *homogeneous*, but variable in its *colour* and *consistence*.

28. That, towards the *latter* stages of chymification, it becomes more *acid* and *stimulating*, and passes more rapidly from the stomach.
29. That the *inner coat* of the stomach is of a pale *pink* colour, varying in its hues according to its full or empty state.
30. That, in health, it is sheathed with mucus.
31. That the appearance of the interior of the stomach *in disease* is essentially different from that of its *healthy* state.
32. That stimulating *condiments* are injurious to the healthy stomach.
33. That the use of *ardent spirits always* produces disease of the stomach if persevered in.
34. That *water*, *ardent spirits*, and most other *fluids*, are not affected by the gastric juice, but pass from the stomach soon after they have been received.
35. That the *quantity* of food generally taken is more than the wants of the system require; and that such excess, if persevered in, generally produces not only functional aberration, but disease of the coats of the stomach.
36. That *bulk* as well as *nutriment* is necessary to the articles of diet.
37. That *bile* is not ordinarily found *in the stomach*, and is *not* commonly *necessary* for the digestion of the food; but,
38. That when *oily* food has been used, it assists its digestion.
39. That *oily* food is difficult of digestion, though it contains a large proportion of the nutrient principles.
40. That the *digestibility* of aliment does not depend upon the *quantity* of nutrient principles that it contains.
41. That the natural temperature of the stomach is about 100° Fahrenheit.

42. That the temperature is *not elevated* by the ingestion of food.
43. That *exercise elevates* the temperature; and that *sleep* or *rest*, in a recumbent position, *depresses* it.
44. That *gentle exercise* facilitates the digestion of food.
45. That the time required for that purpose is various, depending upon the quantity and quality of the food, state of the stomach, &c.; but that the time ordinarily required for the disposal of a moderate meal of the fibrous parts of meat, with bread, &c., is from three to three and a half hours.

A few more inferences are given, but are here omitted, because they refer exclusively to the *chyle*, which has not yet been treated of. The second and seventeenth are, perhaps, too strongly expressed. A complete change of diet, for example, causes *some* variation in the gastric juice, although the latter inference, taken in a literal sense, affirms the contrary

CHAPTER VI.

CHYLIFICATION, AND THE ORGANS CONCERNED IN IT.

Chylification.—Not well known.—Organs concerned in it.—The intestinal canal.—Its general structure.—Peritoneal coat.—Mesentery.—Muscular coat.—Uses of these.—Air in intestines.—Uses of.—Mucous coat.—Analogous to skin.—The seat of excretion and absorption.—Mucous glands.—Absorbent vessels.—Course of chyle towards the heart.—Nerves of mucous coat.—Action of bowels explained.—Individual structure of intestines.—The Duodenum—Jejunum—and Ileum.—Liver and pancreas concerned in chylification.—Their situation and uses.—Bile, its origin and uses.—The pancreas.—Its juice.—The jejunum described.—The ileum—Cœcum—Colon—and Rectum.—Peristaltic motion of bowels.—Aids to it.—Digestion of vegetables begins in stomach, but often finished in the bowels.—Illustration from the horse.—Confirmation by Dupuytren.

The conversion of food into chyme, an operation which, as we have seen, takes place in the stomach, is only one of the series of changes which aliment undergoes before becoming fit to be assimilated with the living body; and the next process which we have to notice is *chylification*, or that by which *chyme* is converted into *chyle.*

In proportion as chyme is formed from the food, it is gradually propelled, as already shown, through the pyloric orifice of the stomach into the duodenum, or beginning of the small intestine. On its arrival there, it is acted upon by the *bile* from the liver, and the *pancreatic juice* from the pancreas; and the result is the separation of the chyme into two distinct substances,—the one a milky-white fluid called *chyle*, which is absorbed into the system, and forms nutriment,—and the other a yellowish and more consistent mass, which is the indigestible remains of the food, and which, after travers-

ing the whole length of the intestinal canal, and being there mixed with the waste matter separated from the blood in order to be thrown out of the system through the same channel, is at last expelled in the form of *fæces* or excrement.

If physiologists experience much difficulty in satisfactorily explaining all the phenomena of *chymification*, or *stomach-digestion*, the reflecting reader will not be surprised to learn that they are still more puzzled to account for those of chylification, or *intestinal digestion*. The organs concerned in the latter are so deep-seated and inaccessible during life, that very few opportunities occur of obtaining accurate information on the subject; and, therefore, in what follows, I shall not enter into disputed or intricate details, but confine myself to such general views as are not contested, and as the reader may easily understand. Fortunately, ignorance of this branch of the inquiry is of less practical importance than if it extended to stomachic digestion also; because such is the harmony between all the parts of the system, that whatever conduces to the perfect accomplishment of the first stage of the process, *chymification*, is in so far equally conducive to the proper fulfilment of *chylification*, or intestinal digestion.

The simple fact, indeed, of our having no *direct* control over the process of chylification, and of our being able to modify it only by varying, through the medium of the stomach, the elements out of which chyle is to be formed and the mode in which they shall be digested, is a proof that, practically speaking, it is chiefly the laws or conditions of stomachic digestion which are intended to regulate our conduct; and that, in obeying them, we in reality obey also those of intestinal digestion.

The organs concerned in chylification are the *duodenum*, the *liver*, and the *pancreas*; but in order

to avoid repetition, I shall, in describing the first, notice also the remainder of the intestine.

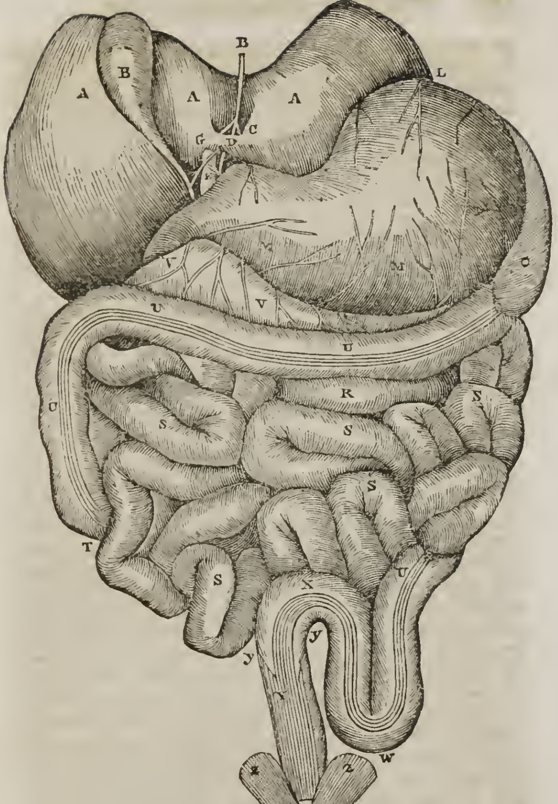
The *intestine*, or *intestinal canal*, as represented in the subjoined figure, begins at the pyloric orifice of the stomach, P, and after many windings and turnings, called *convolutions* (from the Latin word *convolutus*, rolled or folded together), terminates in the *rectum* or *straight gut*, Y, at the external orifice called the *anus*. Although continuous throughout its whole extent, the intestinal tube is nevertheless divided by anatomists into six portions, to each of which a different name is assigned; the distinction between some of these is more nominal than real, but it still continues to be made on account of its convenience.

The first grand division is into the small and great intestines; the former beginning at the stomach, including all the convolutions marked RSSSS,—and the latter beginning at T, where the small intestine terminates, and including the large gut UUUUXYY, which surrounds, and is partly hidden by, the other bowels.

The small intestines, again, are subdivided into three portions,—the *duodenum*, the *jejunum*, and the *ileum*; and the larger, in like manner, into three portions—the *caput cæcum*, or simply the *cæcum*, the *colon*, and the *rectum*. Of the whole length, the small intestines constitute by much the greater part, and they differ somewhat from the larger in function as well as in magnitude.

In *structure*, the intestines exhibit a great analogy with the stomach. They consist, in common with it, of three coats or layers of membrane; the *outer*, or *peritoneal*,—the *middle*, or *muscular*,—and the *internal*, *mucous*, or *villous*.

The *peritoneal* coat is the white, firm, smooth, shining, and moist membrane, seen on the outside of the intestine on opening the cavity of the abdomen. It serves both as a support and as a medium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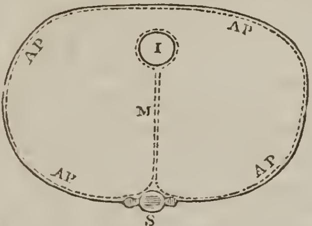
of attachment to fix the intestine in its place. By its smooth, soft, and lubricated surface, it admits readily of the change of place among the bowels necessarily produced by respiration, exercise, and even by different degrees of distention of the bowels themselves. Every time we breathe an undulating motion is communicated to the whole intestines, which facilitates their action, but which could not take place unless they were capable of gliding easily and freely over each other. The peritoneal coat, being strong, extensible, and elastic, is very useful also as a support to the other coats.

The peritoneal coat, after forming the outer covering of the intestine, represented by the dotted line round the circle I in the figure on next page, is continued from it in the form of a double membrane (represented by the two dotted lines) towards the spine S, to which it is first firmly attached by cellular substance; after which the folds again separate, each being continued, or *reflected*, as it is called, over the whole inner substance of the cavity of the abdomen in the course shown by the dotted line, the figure itself representing a transverse section of the abdomen. By this arrangement two important objects are attained. *First*, the abdominal peritoneum AP forms a soft lubricated surface, corresponding to that of the bowels themselves; and, *secondly*, a firm point of attachment for the bowels is secured, by which they may be supported in their proper places, and at the same time admit of some change of position. The floating portion of the peritoneum, M, by which the attachment is effected, is called the *mesentery* (from μεσος, *mesos*, the middle, and εντερον, *enteron*, intestine). But the intestinal canal being so much longer than the portion of the spine to which the mesentery is attached, the latter is necessarily disposed in folds, converging towards the spine, something like the folds of a fan converging towards its narrow end.

In this way the mesentery, besides serving as a support to the gut, serves also to receive and afford protection to the numerous vessels, nerves, and lacteals, which are copiously ramified on every portion, particularly of the small intestines. This



feature, however, will be better understood by inspecting the wood-cut on page 154, representing a portion of the bowel II, as attached to the spine by the mesentery MM, along which the absorbent vessels or lacteals LL are seen to pass from the gut towards the thoracic duct TD.

The portion of peritoneum by which the small intestines are fixed to the spine, constitutes what is properly called the *mesentery.* That portion by which the larger bowel is attached is called the *mesocolon,* from its enclosing the colon; but in other respects the membrane presents no difference.

The *muscular* coat is composed principally of transverse and longitudinal fibres, and its sole object here, as elsewhere, is to effect *motion.* By the alternate contraction of the two kinds of fibres, the contents of the gut are gradually propelled in a downward direction, just as we see a motion propagated from one end of a worm to the other; and hence it is sometimes called the *vermicular motion* (from *vermis,* a worm). Some nauseating substances, such as emetics, have the power of *inverting* the order of the muscular contractions, and direct-

ing the contents upwards instead of downwards—whence vomiting ultimately arises. Other substances, again, have the property of exciting the *natural* action to a higher degree, and consequently propelling the contents faster downwards—in other words, of purging. Rhubarb, aloes, and similar laxatives, especially when combined with tonics, act in this way, and are consequently best adapted for obviating the kind of costiveness which arises from imperfect intestinal contraction. In a natural mode of life, the muscular coat is greatly aided in its operation by the large abdominal and thoracic muscles, brought powerfully and frequently into play during active exercise and employments. When this aid is withdrawn, as it is in sedentary people, the intestinal action often proves insufficient for the purpose ; and hence the costiveness which is so invariable an attendant on most females, literary men, and others whose occupations deprive them of active muscular exercise in the open air. In females, the use of tight stays renders the free expansion of the chest, and corresponding motion of the abdomen, altogether impossible, and thus aggravates the evils of their sedentary mode of life. Hence also the peculiar fitness, in such cases, of the class of purgatives above alluded to, in preference to those of a saline nature, which act chiefly by stimulating the mucous surface to farther secretion.

In addition to the ordinary longitudinal and transverse fibres, the colon presents three remarkable muscular bands running along its whole length, and one of which is represented on the colon in the figure on page 140. On the rectum all the three bands are seen. It is in the colon and rectum that the feculent matter accumulates before it is thrown out of the bowels, and these bands are useful chiefly by adding to their propelling power.

The natural tendency of muscular fibre being to

contract, it may naturally be supposed that, after the intestine is emptied, its opposite sides will come into contact, and, by thus obliterating the cavity altogether, present an obstacle to the subsequent passage of any solid matter. But, on inspecting the abdomen after death, we rarely meet with any considerable portion thus contracted; and in general, the whole intestines are distended to a greater or less degree, according to circumstances. The agent by which this effect is brought about, is one known more familiarly by the inconveniences and pain to which it gives rise when in excess, than by its proper uses, which are nevertheless important. I allude to the presence of air in the bowels, which is as necessary to their healthy action as their muscular contraction itself. Air, in fact, by its expansive energy, forms the antagonist power to the muscular coat, and serves to dilate the bowel after the requisite contraction has propelled its contents. A certain degree of distention, indeed, not only is a stimulus to farther muscular contraction, but is useful in facilitating the passage of the subsequent portions of the feculent matter; and hence the injection of air into the bowels in large quantity, has lately been employed successfully in overcoming obstinate constipation.

The *mucous*, *internal*, or *villous* coat of the intestine, also resembles in many respects that of the stomach. It is a soft, velvety membrane, full of wrinkles or folds through the greater part of its course, by means of which its surface is greatly increased in extent, so as to afford ample space for the ramification of the bloodvessels, nerves, and absorbents, with which it is very plentifully supplied. The cut on p. 161 will convey some idea of its appearance, as seen in the smaller intestine. So far as nutrition is concerned, the mucous coat is the truly *essential* part of the bowel. It alone is in direct contact with the chyme, and in its cavity the

bile and pancreatic juice perform their respective parts, and give rise to the formation of chyle, which is afterward transmitted from its surface into the general system. The peritoneal and muscular coats are useful only in affording protection, and communicating the power of propelling its contents.

The mucous coat appears, on examination, to be so entirely continuous with the skin, that no line of demarcation can be detected between them either at the mouth or at the anus. In structure they greatly resemble each other, and the sympathy between them is well known to be very rapid and intimate. Eruptions on the skin, for example, are almost always owing to disorder of the digestive organs; and bowel-complaint, on the other hand, is often produced by a sudden chill on the surface. In like manner, in enormous eaters like those formerly mentioned, an immense exhalation takes place from both the skin and the bowels, and in many instances the one supplies the place of the other in a considerable degree. We have seen, moreover, that in the lowest tribes of animals, the digesting surfaces and skin are not only undistinguishable, but actually convertible into each other by the simple process of turning the animal inside out, when each will perform the function of the other as well as if it had never done any thing else.

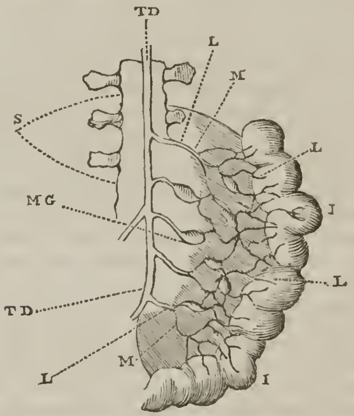
In common with the skin, too, the mucous coat is charged with the double function of *excretion* and *absorption*. For the former, it is eminently fitted by its plentiful supply of blood, and by the great number of minute vessels ramified on its surface, from the extremities of which the excretion takes place. It is by this channel that much of the waste matter requiring to be removed from the body is thrown out. Being poured into the cavity of the intestine from the small arterial branches, it mixes there with the indigestible residuum of the food and bile, and, united with them, forms the common feces or ex-

crement. When the blood is suddenly repelled from the surface by a chill, and thrown in upon these vessels in large quantity, the natural excretion is sometimes increased to such an extent as to constitute bowel-complaint; while at other times, that peculiar form of action is induced which constitutes inflammation. The local stimulus of some kinds of food, and of many medical substances, also excites the secretion to unusual activity. Salts, for instance, have this effect, and thus often *produce* numerous fluid evacuations, the substance or materials of which did not before exist in the bowels; and hence the mistake into which many fall, of taking more medicine on the ground of this effect proving that much stuff was lodging in the bowels—when, in fact, it was not only removed, but *created* by the physic. It is from exciting a fluid discharge of this description, that saline purgatives are so useful for lowering the tone of the system when that is required; but, for the same reason, they are most improper where relaxation and debility already exist. In the cholera, almost the whole fluids of the body are carried off by this channel, leaving the blood too thick in consistence to circulate longer through the smaller vessels.

The excretions from the minute arterial branches ramified on the internal coat are mingled with a bland fluid from the mucous follicles, the evident use of which is to protect from injury the sensitive surface of the intestine. Occasionally, however, the mucous secretion becomes so abundant and viscid as to adhere with unusual force, and to impede the formation and absorption of the chyle, and even the action of the usual purgatives. Worms are then common, and cannot be expelled except by remedies which tend to remove the mucus in which they live imbedded.

To fit the mucous coat for its office of *absorption*, an immense number of minute vessels, called *absor-*

bents, are ramified on its internal surface, the nature and purposes of which are analogous to those mentioned in the former volume when describing the functions of the skin.* In both structures the absorbents are small capillary or *hair-sized* vessels, so infinite in number that at least one goes to every little point or *papilla*. Those which open upon the inner surface of the smaller intestines, and which suck in or absorb the chyle, are called *lacteal absorbents*, or simply the *lacteals*, or milk-vessels (marked LL in the subjoined wood-cut), from the white col-



our of the chyle shining through them, and giving them the appearance of vessels full of milk. In that part of the gut they are so numerous, that every minute point of the villous coat may be seen by the aid of a microscope to contain one, with its mouth open to receive the chyle as fast as it is formed:

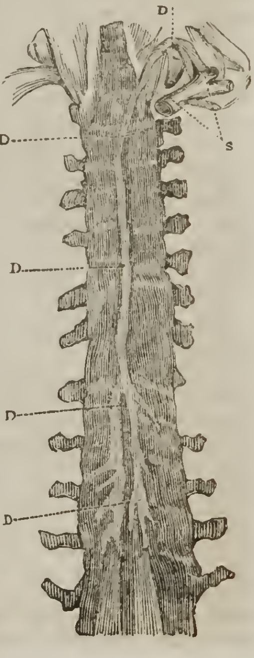
* Principles of Physiology, &c., chap. ii.

Even in the colon the absorbents are numerous; but, as all traces of chyle have there disappeared, they are much fewer than in the smaller intestines. In the colon they serve chiefly to remove the more watery portions of the intestinal contents, by which means the feces are rendered more solid and less bulky, and therefore better adapted for being retained for a time without inconvenience. It sometimes happens that, when food or medicine cannot be swallowed in the usual way, life is preserved by injecting it into the bowels; in which case the absorbents of the large gut become active, and carry it into the system. Opium laxatives and other remedies are often administered in the same way, when any reason exists against giving them by the mouth.

There are absorbents in every structure of the body, because there are everywhere waste particles to be taken up and removed; but, except in the case of the lacteals, their contents are *limpid*, or colourless, and hence in other places they are called *lymphatics:* in almost every other respect, however, the two classes of vessels are analogous to each other.

The peculiar property by which the minute lacteal vessels take up the white chyle is not well understood. From the fact in physics that liquids rise in capillary tubes, the inference has been drawn that absorption in living vessels also takes place from capillary attraction. But in the animal body the application of the principle is undoubtedly modified by the properties peculiar to organization, and one of the most remarkable proofs of this is the circumstance of the absorbent vessels in different situations having to some extent a specific adaptation to the qualities of the substances upon which they are severally destined to act. At one time, indeed, it was supposed that the principle of exclusive adaptation was so complete that every absorbent vessel was permanently shut to every thing except its own

peculiar object, and that, from amid many elements, each selected its own with unerring tact. But of late it has been proved that the absorbents are less rigidly discriminating than was previously supposed, and that substances are readily taken up by them which nature never intended them to receive. In mixing madder with the food of fowls, for example, for the purpose of dying their bones, the colouring matter of the root is taken up without difficulty by the absorbents along with the chyle, although madder was certainly never intended to be their natural stimulus. But even admitting this latitude in its fullest extent, there still exists a fitness and peculiarity of relation between the absorbents and their *proper* objects, which renders the latter more accessible to them than any foreign body.



The lacteal vessels are most easily seen an hour or two after a meal; because they are then fully distended with chyle, even in their smaller branches. The latter, indeed, may then be distinctly traced proceeding from the different portions of intestine, and gradually coalescing into larger trunks, as seen at LL in the figure on p. 154.

These, again, terminate in the vessel called the thoracic duct (the beginning of which is seen at TD in the same figure), by which the chyle is conveyed almost in a direct course along the spine, and which is represented at DDDD in the preceding cut. On its arrival at the upper part of the chest, the thoracic duct crosses over and opens into the vein S, just before the latter reaches the right side of the heart, so that the chyle is there poured into the circulating current of the *venous* blood.

Such is the course of the chyle. But the lacteal absorbents, in their progress from the intestine to the thoracic duct, pass through the small glandular bodies called the mesenteric glands (M. G. p. 154), where some change, the nature of which is not at all understood, is produced upon the chyle, but which seems nevertheless to be of importance to its constitution. Where these glands are hardened and enlarged, as they often are in scrofulous children with large prominent bellies and thin bodies, nutrition is greatly impaired, although the appetite and stomachic digestion remain comparatively unaffected.

The reason why the chyle is carried so far to be poured into the current of the venous blood, just before the latter reaches the right side of the heart, is, on consideration, not less obvious than cogent. Chyle itself is not fitted to become a constituent part of the animal frame. Before it can become so, *it must be converted into blood*; and this can be effected only by exposing it to the action of the air, in the air-cells of the lungs, in a state of intimate mixture with the venous blood. This admixture, again, is ensured by the gradual way in which the chyle advances along the thoracic duct, and falls into the circulating current almost drop by drop; and it takes place just before the dark blood has finished its course, and is again subjected to complete *aëration* in its passage through the lungs. As explained in the

former volume, this aëration is so indispensable to the renovation of the old and the formation of new blood, that whenever it is rendered imperfect, either by obstructions in the lungs themselves, or by the absence of a sufficiently pure air without, the result is invariably injurious to health; because the blood, being no longer properly constituted, becomes incapable of furnishing a healthy stimulus and nourishment to all the parts of the body. Hence the rapid "decline" which follows the appearance of pulmonary consumption, and other diseases affecting the structure, and interrupting the functions, of the lungs.

Everybody knows as a fact that bad air is hurtful, and that wasting disease of the lungs is attended with rapid loss of flesh and strength; but the manner in which these effects are produced is not so familiarly known. Yet, in a practical point of view, a knowledge of the principle is highly important. Properly considered, *respiration is in reality the completion of digestion.* The stomach may convert the food into chyme, the small intestines may convert the chyme into chyle, and the absorbents may take up the latter, and duly convey it into the circulating system; but, unless it undergo the necessary change in the air-cells of the lungs, it will not constitute good blood, or afford due nourishment to the body. Hence it is that those among the working classes who are much confined in an impure and insalubrious atmosphere, even when plentifully supplied with food, are generally thin and ill-nourished; and hence those who, along with good digestion, have small narrow chests, and very limited respiration, are commonly found to be constitutionally lean,—while those who, along with good digestion, have amply-developed lungs, and free and powerful respiration, are at the same time remarkable for proportional vigour of nutrition and stoutness of body. It is on this account that in chronic pulmo-

nary disease recovery is always to be distrusted, unless, along with the disappearance of the prominent symptoms, restoration of the lost flesh occurs. If nutrition remains impaired, however great the relief may be in other respects, there is reason to believe that the lungs are still so extensively diseased as to injure their functions, and that, on the application of any fresh exciting cause, the dormant mischief will resume its activity. In such cases, when stomachic digestion is sound, a full diet generally over-stimulates the system, by pouring into the blood more chyle than the lungs are able to assimilate; in consequence of which it is diffused over the whole body in an imperfect state of preparation.

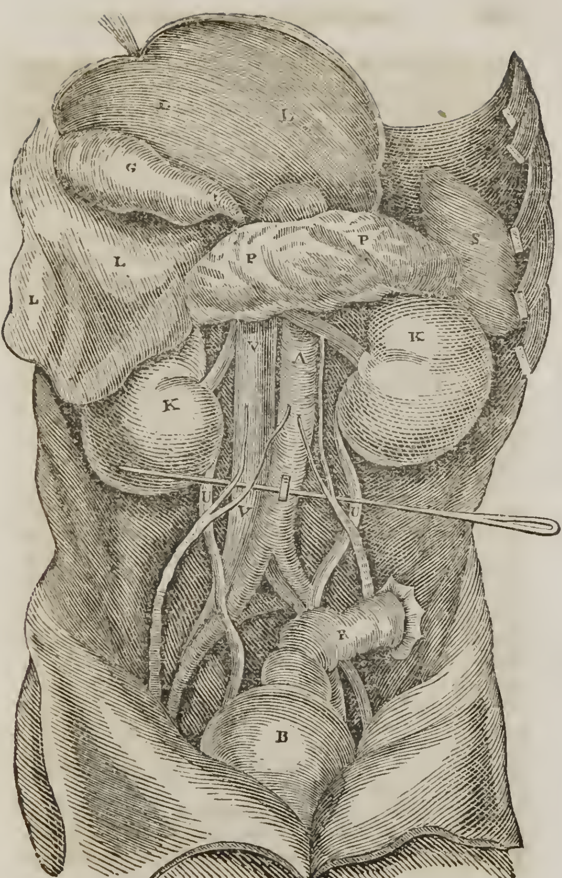
The mucous membrane is, like the skin, well provided with *nerves*, and has a mode of sensation peculiar to itself. Every villous point, indeed, has a nervous fibre ramified on it, to give it the necessary sensibility to its own stimuli. It is true, we are not so conscious in health of the impressions made on the intestinal nerves; but this, as already shown in describing the stomach, is a privilege and not a defect. They recognise their appropriate stimuli, and cause the necessary actions to follow without requiring aid from the will. But when they meet with substances which ought not to be there, such as pieces of indigested food, or foreign bodies which have no natural relation to their constitution, they immediately indicate uneasiness, and excite the muscular contractions to rid them of the offending cause.

To secure full and natural action in the intestinal canal, several principal conditions are thus necessary, failure of any of which may impair their activity. The first condition is well-digested chyme and chyle; the second, a due quantity and quality of mucous and vascular secretions from the villous coat; the third, full contractile power in the muscu-

lar fibres of the intestine, and free action of the abdominal and respiratory muscles; and the last, a due nervous sensibility to receive impressions, and communicate the necessary stimulus. And hence, when the bowels act imperfectly, it is of importance to ascertain to what cause the inability is to be ascribed, that an appropriate treatment may be devised.

Such are the general structure and uses of the intestinal canal; but there are modifications in its individual portions on which it may be right to offer a few additional remarks. We shall begin with the *duodenum*.

The *duodenum* (from *duodeni*, twelve, being considered equal in length to twelve finger-breadths) commences at the pyloric orifice of the stomach, from which it crosses over, under the lower surface of the liver, towards the right side; it then descends in front of the right kidney, and there forming a second curve, it proceeds again towards the left, and a little beyond the spinal column, terminates in the jejunum. It thus describes a course like the letter C, and has its convexity turned towards the right, while the *pancreas* or sweetbread (PP) lies in the space enclosed by its concavity. To enable the reader to form some notion of the relative position of these parts, I have introduced a wood-cut on the next page, showing the situations and appearance of the different organs after the intestines, as in the figure on page 147, have been removed from the body. The letters LLLL point out the inferior surface of the liver, a little raised from its natural position, to show the gall-bladder G, and the pancreas PP, round the right end of which the duodenum is curved. S indicates the spleen, with a vacant space over it, in which the stomach lies. The kidneys, KK, lie one on each side of the spine; and the two pipes UU are the ureters, which convey their se-


L
G
P
P
S
L
L
K
V
A
K
U
V
U
R
B

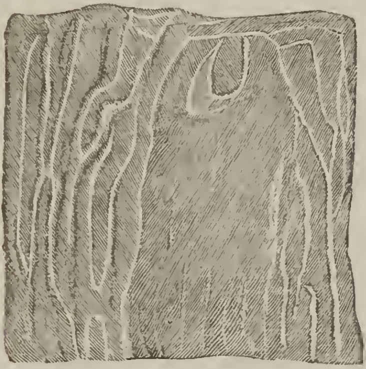
creted fluid to the bladder B. The letters AA indicate the great artery (the *aorta*), through which the nutritive blood descends to supply the bowels and lower parts of the body; and VV mark the corresponding vein (the *cava*), by which the dark blood returns from the extremities towards the heart. R is the beginning of the *rectum*, or straight gut, seen at YY in the cut on page 147.

The duodenum, being thus in the immediate vicinity of the spine, is fixed firmly down in its position by the connecting membrane, and is not left to float loosely in the cavity of the *abdomen* or belly. Had it not been tied down in this way, it would not only have acted by its weight as a continual drag upon the stomach, and disturbed its functions, but likewise have been constantly altering its own relation to the pancreatic and hepatic (or liver) ducts, and thereby affecting the flow of their respective fluids into its cavity, by which chylification would have been often interrupted.

The duodenum is much smaller in diameter than the stomach, but larger than the *jejunum* or *ileum*; and its muscular coat is also thicker. From its size and the importance of the changes effected in it, it has been considered by some as a secondary stomach, or *ventriculus succenturiatus*. It is more firmly fixed to the body than the other intestines, and does not, like them, float loosely in the abdomen. In its course, until its termination in the jejunum, it describes a kind of C, the concavity of which looks to the left. From this shape it has been separated into three portions—the first situated horizontally beneath the liver; the second descending vertically in front of the right kidney; and the third in the transverse mesocolon.

Its mucous membrane presents a number of circular folds, as shown in the subjoined wood-cut. These folds or *rugæ* are called *valvulæ conniventes*,

or *folding valves*, and are inherent in the nature of the mucous coat, and not produced by mere folds of the whole thickness of the intestine, consequently they exist even when the latter is distended. They are comparatively few in number in the part of the duodenum near the stomach, and gradually multiply in the course downwards till they arrive at the maximum of development at its lower end and



in the jejunum; they again diminish in the ileum, and disappear altogether in the larger gut. The bloodvessels and nerves of the duodenum are extremely numerous, and indicate the importance of its functions.

The duodenum serves to receive the chyme as it issues from the stomach, and to prepare it for the farther action of the agents of digestion. The biliary and the pancreatic juices contribute most to chylification. The pancreas is the largest of the

salivary glands. A considerable excretory duct passes entirely through this organ, and opens into the duodenum. The excretory portion of the biliary system includes the proper excretory duct of the liver, and a cul-de-sac of this canal termed the gall-bladder. The bile is generally distinguished into cystic and hepatic. From this peculiarity it is legitimately enough inferred that the liver serves the double purpose of providing a fluid indispensable for chylification and the proper action of the bowels as organs of excretion, and also of separating from the venous blood useless or spent materials, which require to be thrown out of the system. The influence of the bile as a stimulant to the bowels is proved by the fact that costiveness ensues when it is deficient in quantity, and an opposite condition when the secretion is redundant, as during the heat of autumn.

Bile is a bitter, viscid, greenish-yellow fluid, the taste and general appearance of which are familiar to most people; and the office of which in the animal economy must be one of no small moment, if it be justly chargeable with even a tenth part of the catalogue of human ills which are laid to its account. Its secretion seems to go on continuously; but the quantity produced depends much on the amount of venous blood which is circulating through the liver at the time. Hence, in health, it is always greatest soon after a meal; because, as we have already seen, the supply of blood in both the arteries and the veins connected with digestion is then at its maximum.

But as the secretion of the bile is constantly going on, and its presence in the duodenum is required only when the latter contains chyme, a contrivance becomes requisite for storing it up in the interval, to be ready for use when wanted. This is effected by the small shut sac or bag G, named the *gall* (or

bile) *bladder*, which adheres to the lower surface of the liver, and is always most full after a fast of some duration. The bile contained in the gall-bladder is generally more viscid, dark, and bitter than that which proceeds directly from the liver—apparently from the absorption of its more fluid parts. It is in this bag that *gall-stones*, as they are called, are sometimes formed, and it is their passage through the narrow tube in which it terminates that causes the acute pain so often complained of in that affection.

From the liver the bile is conducted into the duodenum through a membranous tube of about the diameter of a quill, and which is called the *biliary* or *hepatic duct*. In its course a similar pipe, called the *cystic duct* (from κυστις, *kystis*, a bladder), from the gall-bladder, unites with it into one trunk, like the two limbs of the letter Y; and this trunk enters the duodenum by an orifice common to it and the pancreatic duct.

In the healthy state bile is to be found only in the duodenum, and not in the stomach; although one would suppose the contrary from the familiar way in which we speak of the stomach being oppressed with bile, and of our being "very bilious." When vomiting is excited, either artificially or by illness, we no doubt often bring up plenty of bile. Sometimes this bile has been existing in the stomach, and causing nausea; but very often it is brought into the stomach solely by the inverted action which constitutes vomiting, and was consequently placed there by the very remedy which is supposed to have cleared it away. The process of vomiting is accompanied by an inverted action of the intestinal canal, whereby it propels its contents upwards instead of downwards, and thus the bile is, as it were, forced up from the duodenum into the stomach, instead of being propelled downwards and ex-

pelled in the usual way. Hence, in sea-sickness for example, the first fits of retching generally bring up nothing but food or mucus—the real contents of the stomach,—and it is only after continued straining that bitter bile makes its appearance. In the healthy state, fat or oily food often causes the presence of bile in the stomach, as if its aid were necessary there for the accomplishment of digestion.

The *pancreas*, or sweetbread, PP, is a large oblong gland, which lies across the spine, and secretes a fluid almost identical with the saliva. Its duct, as stated above, enters the duodenum along with the biliary duct, so that the two fluids meet at their entrance, which takes place at the first curvature of the intestine, at the distance of about one third of its whole length from the stomach.

The bile and pancreatic juice, thus poured out together, are both requisite for the formation of chyle, and apparently modify the action of each other. The bile being somewhat of an unctuous nature, and the pancreatic juice somewhat alkaline, their union forms a kind of saponaceous compound, which is less irritating, and more easily incorporated with the chyme, than pure bile.

In proportion as the chyme is formed and expelled from the stomach it is received into the duodenum, where it probably undergoes some farther change, even before arriving at the entrance of the biliary or pancreatic ducts. From the numerous folds or wrinkles which line the inner surface of the duodenum, and impede the motion of its contents, and also from the intestine itself being more fixed down, and less subjected to the influence of the movements of respiration, the progress of the chyme along its surface is very slow. Every particle of chyme is thus allowed to receive its share of the bile and pancreatic juice as it proceeds on its course, and time is afforded for the requisite changes taking place.

By simply stating that, in the duodenum, the

chyme becomes mixed with the two fluids just mentioned, and that the result is its separation into a fluid, milky, and nutritive portion, named *chyle*, which is absorbed by the lacteals, and a darker, yellow-coloured, thickish mass, which remains in the bowel, we communicate to the reader almost every thing that is known on the subject. Theories and conjectures could be added, but scarcely any facts of a very positive nature.

The remainder of the small intestine, namely, the *jejunum* (from *jejunus*, fasting or hungry, because it is generally empty), and the *ileum* (from ειλεω, *eileo*, I twist or turn about), marked RSSSS in the cut on p. 147, are merely continuations of the duodenum, and have precisely the same number of coats and the same general structure. The inner surface presents the same kind of folds or *rugæ*, whereby the extent of the mucous membrane is increased, and ample space given for the ramifications of blood-vessels, and the origin of the absorbents by which the chyle is sucked up and carried into the system. *Exhalation* or *exudation* also goes on from their surface, and in bowel complaints often becomes so excessive as in a few days to reduce the patient to the extremity of emaciation and weakness.

As the contents of the jejunum and ileum advance, the proportion of chyle in them becomes smaller and smaller, and the residual matter becomes more and more consistent, yellow, and fetid—approaching, in short, to the ordinary appearance of excrement when expelled from the body. In accordance with these changes, the number of absorbent vessels, and the distinctness of the villous folds, gradually diminish as we proceed downward, till, on arriving at the termination of the ileum, in the colon, or great gut, they altogether disappear, and the contents assume the colour, smell, and appearance by which excrement or feculent matter is characterized.

The division between the small and great intestines is indicated, not only by marked differences in their diameter and external appearance, but also by an internal valve placed between them, the object of which is to prevent the contents of the colon from following a retrograde course and returning to the ileum. It is also worthy of notice, that the colon is not a gradually enlarged continuation of the ileum. On the contrary, the latter enters the side of the colon almost at right angles to its course, at a little distance from its commencement. The small portion of the colon which thus lies at one side of the entrance of the ileum, and which has of course no opening at its extremity, is thence called the *caput cæcum coli*, or *blind head* of the colon, or simply the *cæcum*. Its position is at T in the figure on p. 147, but it is hidden by the folds of the ileum.

The *colon* (from κοιλον, *coilon*, hollow) or great gut UUU in the same figure, constitutes not more than one fifth in length of the intestinal canal. It begins at the lower part of the right side of the belly, at T in the cut on page 147; rises upwards on the same side towards the liver; crosses over to the left side in contact with the stomach; descends along the left side of the abdomen; makes a turn at UWX like an italic *s* (and hence called *sigmoid* flexure), while lying on the left haunch-bone; and lastly, terminates in the *rectum* or *straight gut* YY at the *anus*. Being fixed by local attachments, the colon remains always in the same situation, and thus describes a figure not unlike a square, in the centre of which lie the whole of the smaller intestines. In the cut referred to, the left portion is hidden behind them.

The diameter of the colon is about double that of the small intestines. In structure it is analogous to them, having three coats; but the *valvulæ conniventes*, or folds of the mucous coat, are no longer to

be seen, and with them all traces of chyle and chyle-bearing vessels also disappear. The colon serves more as a reservoir for waste or excrementitious matter than as a vital organ. Absorption is carried on from its inner surface, but through the medium of lymphatic absorbents and minute venous ramifications, and not of lacteals. Hence not only food, but medicine, are frequently administered by being injected into the rectum, and life has been saved in this way when nothing could be given by the mouth.

The passage of the intestinal contents from the stomach downwards is effected chiefly by the *peristaltic* or *vermicular* motion, that is, the successive muscular contraction of the middle or fleshy coat already frequently adverted to; and this, in its turn, is greatly aided by the constant but gentle agitation which the whole digestive apparatus receives during the act of breathing, and during exercise of every description. In inhaling air into the lungs, the diaphragm is depressed, the bowels are pushed down, the walls of the belly yield, and it becomes protuberant. When air is thrown out from the lungs, the diaphragm rises into the chest, the bowels follow, and the belly becomes flattened and drawn in. The stomach and bowels are thus placed between, and receive a never-ending impulse from, two bodies differently placed and in continual motion. During exercise breathing is deeper, and muscular contraction greater in power and in extent; and hence the assistance afforded is also increased. Those who take no exercise, or who have the chest and bowels confined and bound down by tight stays and bandages, lose this natural stimulus, and have, in consequence, the bowels obstinate and troublesome.

The great extent and capacity of the intestinal canal in herbivorous animals, and others living on bulky and innutritious food, have been already no-

ticed, and their reason explained. Perhaps it ought to be added, that an additional reason is the fact that the digestion of vegetable nutriment is not, like that of animal food, completed in the stomach, but in the intestines. It is familiarly known, for example, that when digestion is weak, fruits and fresh vegetable aliments often pass through the bowels very little changed; and that, even at the best, they are digested more slowly than animal food. On examining the bodies of animals at different intervals from the time of feeding, the distinguishing fibrous structure of vegetable food is observed to diminish in proportion to its distance from the stomach, and it does not finally disappear till it is nearly arrived at the end of its course. From this it has been inferred, that the digestion of vegetable matter is only partially accomplished in the stomach, and that it requires the aid of the intestinal juices for its completion. Delabere Blaine arrives at the same conclusion, from considering the peculiar digestion of the horse. In the horse, the stomach is a simple bag, of very moderate size, and yet that animal not only can drink a gallon or two of water at a time, but can eat a much larger quantity of hay or grass than its stomach seems to be capable of containing. Blaine explains this by stating that, in reality, oats and hay are not long retained in the stomach, and that, after receiving the requisite supply of gastric juice, and undergoing its influence to some extent, they are gradually propelled towards the duodenum, where their digestion is continued, but not completed till long after being subjected to the action of the bile and pancreatic juice, and passing through the remainder of the small intestine. It is owing, he adds, to this speedy evacuation of the stomach, that the horse is less inclined to drowsiness, and less incommoded by active exercise soon after meals, than almost any other animal.

The late Baron Dupuytren had several opportunities of observing something analogous to this in the human subject. He had, at various times, under his care, patients in whom an opening into the intestine had taken place at different distances from the stomach, and through which the intestinal contents readily escaped. On giving several kinds of food at one meal, he remarked that they presented themselves at the wound in the *inverse* order of their digestibility. Thus, fresh vegetables always made their appearance first, still retaining much of their peculiar structure; while animal substances either did not appear at all, or were so much altered in appearance as scarcely to be recognised. In the natural evacuations, however, the vegetable structure was generally imperceptible; so that a considerable change must have taken place on it as it advanced through the bowels, after passing the seat of the wound.

From the circumstance of vegetable aliment containing *little nourishment* and *much indigestible matter*, it naturally happens that a larger quantity of refuse remains to be thrown out of the bowels when it constitutes the chief part of the diet, than when animal or farinaceous food, which contains *much nourishment* and *little indigestible matter*, is used. Hence, as a general rule, the bowels act more freely, or are more open, in the former than in the latter case; and hence the common saying, that milk, eggs, jellies, and meat, are *binding*. They have the appearance of being so chiefly because they are almost wholly absorbed. But as neither the stomach nor the bowels are adapted in structure for very concentrated food, such articles cannot be long used with advantage. Brown and rye bread, and fruits, are in repute for relieving a costive habit of body, and their usefulness is explicable on the same principle. They leave a large residue to be thrown out of the system, and this residue forms the natural

stimulus of the bowels, and consequently excites them to freer action. This effect is probably aided also by the stimulus which the indigestible refuse imparts to the mucous glands, increasing the lubricating secretion, and giving additional facility to the propelling powers.

In the preceding exposition of the structure and functions of the organs of digestion, many omissions necessarily occur, and many questions of much intrinsic interest are passed over with very little notice. But a minuter survey was incompatible with both the objects and the limits of the work. My great aim was, not to extend the bounds of physiology, but to turn to a useful purpose what is already known in regard to one of its most important departments, and to interest a larger class of people in its cultivation. If I have said enough to make the points of doctrine on which I have touched intelligible to the ordinary reader, and to impress him with a just sense of their practical value, I shall have accomplished the utmost I have sought to attain.

PART II.

THE PRINCIPLES OF DIETETICS VIEWED IN RELATION TO THE LAWS OF DIGESTION.

CHAPTER I.

TIMES OF EATING.

The selection of food only one element in sound digestion.—Other conditions essential.—Times of eating.—No stated hours for eating.—Five or six hours of interval between meals generally sufficient.—But must vary according to circumstances.—Habit has much influence.—Proper time for breakfast depends on constitution, health, and mode of life.—Interval required between breakfast and dinner—best time for dinner—circumstances in which lunch is proper—late dinners considered—their propriety dependant on mode of life.—Tea and coffee as a third meal—useful in certain circumstances.—Supper considered.—General rule as to meals.—Nature admits of variety,—illustrations—but requires the observance of principle in our rules.

Having, in the first part of the present work, traced the progress of the food through its successive stages of preparation for becoming a constituent element of the animal frame, and examined the structure and nature of the various organs engaged in digestion, I shall now endeavour to turn the exposition to account, by making it, as far as possible, subservient to a closer and more rational observance of the laws of digestion, and to a better adaptation

of diet and regimen to different ages, sexes, and constitutions, than that which is generally prevalent. I am deeply sensible of the imperfections which will abound in this part of the work; but, at the same time, I am so strongly impressed with the urgent importance of the subject, and with the success which will infallibly attend its further investigation on sound physiological principles, that I consider the likelihood of personal failure to be of very secondary importance, when compared with the benefits which will accrue to society from the exertions of others whose labours may be more profitably directed by an acquaintance with the guiding principles unfolded in these pages.

According to the popular notions of dietetics, the selection of the proper kind of food seems to constitute the *only* condition required for the enjoyment of healthy digestion. Hence medical men are constantly questioned whether this or that article of diet is good or bad for the stomach, while curiosity rarely, if ever, extends so far as to inquire whether nature has annexed any other conditions which also it may be expedient to know and to observe. In reality, however, the choice of aliment is but one out of many circumstances which require to be attended to; and it often happens that the same food which is digested with ease when the collateral conditions are fulfilled, will remain for hours on the stomach unaltered when they are neglected. Some of these conditions, therefore, I shall now endeavour to point out. And, first, of

Times of Eating.—If we look to the exposition of the objects of eating already given in treating of appetite, it will be obvious that nature intended us to regulate our meals by the demands of the system, and not to eat at stated hours as a matter of course, whether nourishment were required or not. If we are engaged in exercises which induce a rapid

expenditure of material, or if growth is going on so rapidly as to require unusually ample supplies, food ought to be taken both more frequently and in larger quantity than when we are differently circumstanced; or, in other words, *food ought to bear a relation to the mode of life and circumstances of the individual*, and not be determined by a reference to time alone.

As society is constituted, however, there is so much uniformity of occupation in the different classes of which it is composed, and the animal economy is otherwise so much adapted to the performance of periodical operations, that stated times may with advantage be fixed for each class, and thus the benefits of that social and exhilarating intercourse which we all see to be so conducive to healthy digestion may be generally obtained. Individuals may suffer a little from this arrangement, but the vast majority will undoubtedly be benefited.

Where the mode of life is regular and nearly the same throughout a whole class, the same waste will go on, and the same demand for a supply of nourishment occur, throughout all the individuals composing it, subject only to such variations as are induced by original differences of age and constitution. Consequently, as regards such a class, regularity in the recurrence of their meals is not less natural than advantageous; because not only are all the individuals subjected to nearly the same exertions, but every day is so like another, that the want will always be felt at the same hour; and it is only when we attempt to combine the same order of diet with different and even incompatible modes of life, that nature refuses to sanction the arrangement.

So strong, indeed, is the tendency to periodicity in the system, that appetite returns for a time at the accustomed hour, even after the mode of life, and consequently the wants of the system, have undergone a change; and if not gratified it again subsides.

Ultimately, however, it calls with too strong a voice to allow of its being thus disregarded.

Nature has accorded to man considerable latitude in fixing the interval within which the demands of appetite must be gratified, and in this provision has obviously had in view the infinite variety of circumstances in which he may be placed in the discharge of his numerous duties. As a general rule, five or six hours should elapse between one meal and another—longer if the mode of life be indolent, shorter if very active. Digestion occupies from three to four or five hours, and the stomach requires an interval of rest after the process is finished, to enable it to recover its tone, before it can again enter upon the vigorous performance of its function. Appetite, accordingly, does not begin to show itself till some time after the stomach has been empty, and if food be taken before it has recovered its tone, the secretion of gastric juice and the contracting of its muscular fibres are alike imperfect, and digestion consequently becomes impaired.

The interval between each meal ought to be longer or shorter in proportion to the quantity eaten, and to the more or less active habits of the individual; and it would be absurd to fix the same standard for all. A strong labouring man, whose system is subjected to great waste from being engaged all day in hard work, will require not only more frequent, but more copious meals than an indolent and sedentary man; and those who eat very little will require to eat at shorter intervals than those whose meals are heavy. An invalid on restricted diet may thus require to eat every four hours, where formerly, with a more copious diet, once in six hours was sufficient. Some indeed are so constituted as to require only one or two abundant meals in twenty-four hours.

Early training exercises great power over the stomach as well as over the mind. In savage life,

where the supplies of food are precarious, a single meal may be copious enough to serve for two or three days together. The monks of La Trappe make it a part of their religion to eat only once a day, and nothing but vegetable food—unless when sick, in which case milk is allowed; but it is long before they become reconciled to the restriction. I once travelled for three days in a French diligence with one of the order, then on his way from Italy to the Monastery of La Trappe, near Nantes, and observed that he scrupulously adhered to his single meal. He had a dispensation, however, authorizing him to eat animal food and use wine during his journey; and I was surprised at the extent to which he availed himself of the permission, and to see him devour at one time a store sufficient to last for a week instead of a day. But, as in the case of the boa constrictor in similar circumstances, a deep lethargy immediately succeeded, and it was not till four or five hours afterward that his almost apoplectic features became again animated and expressive; long before his time came round, however, his renewed appetite betrayed itself by expressive glances towards the comforts of the breakfast-table.

Nature, then, *has fixed no particular hours for eating*, but has left us to adapt our regimen to our respective ages, constitutions, and modes of life. Where the mode of life is uniform, fixed hours may be adopted; where it is irregular, we ought to be guided by the real wants of the system as indicated by appetite.

According to this principle, meals ought to be early or late in proportion to the habits of the individual. If, adhering to the order of nature, we work by day and sleep by night, then early breakfast, early dinner, and an early evening meal, will undoubtedly be the most conducive to sound digestion and the enjoyment of health. But if, against the laws of nature, we rise from bed late in the

forenoon, reserve our activity till late in the afternoon, and do not go to sleep till two or three hours before daybreak, then assuredly the late breakfasts and dinners of the fashionable society of the present day are the best for our comfort that can be devised; and the chief error lies in the practice of those who, while they in other respects live in conformity with nature, adopt the hours which are suitable for those only who turn night into day and day into night.

The proper time for taking breakfast depends a good deal on the individual constitution and mode of life. Those who eat supper ought not to breakfast till one or two hours at least after rising; but persons who dine late and eat nothing afterward require breakfast sooner. Individuals of a delicate frame are often unable for either bodily or mental exertion in the morning, and are invariably injured by any attempt at exercise or serious thinking before breakfast. Experience is the only sure guide in such cases, but, as a general rule, breakfast about half an hour or an hour after rising will be found most beneficial; and those who rise very early will do well to follow the French custom of taking a small cup of coffee or tea, and bread, on getting up, and reserve their appetite for a more substantial breakfast three hours later. This is an invaluable rule for students, who often seriously impair their digestive functions by studying for hours in the morning, regardless of the craving of the system for nourishment and support.

If exposure of any kind is to be incurred in the morning, whether to the weather or to the causes of disease, it becomes a matter of much importance that breakfast should be taken previously. It is well known that the system is more susceptible of infection, and of the influence of cold, miasma, and other morbid causes, in the morning before eating than at any other time; and hence it has become a

point of duty with all naval and military commanders, especially in bad climates, always to give their men breakfast before exposing them to morning dews or other noxious influences. Sir George Ballingall even mentions a regiment quartered in Newcastle, in which typhus fever was very prevalent, and in which, of all the means used to check its progress, nothing proved nearly so successful as an early breakfast of warm coffee. In aguish countries, also, experience has shown that the proportion of sick among those who are exposed to the open air before getting any thing to eat, is infinitely greater than among those who have been fortified by a comfortable breakfast. Where there is any delicacy of constitution, the risk is of course increased.

The cause of this susceptibility in the morning is not difficult to be discovered. Not only have the stomach, duodenum, and upper intestine been entirely empty for several hours, but the absorbents and other parts engaged in the function of alimentation have likewise been in a state of repose. A considerable exhalation from the skin and lungs has at the same time been going on; and this, taken along with the deposition, which there is reason to believe takes place more actively during sleep, of new particles to the existing organization, necessarily reduces the quantity and quality of the circulating fluids, and gives rise to a certain degree of debility, which is favourable to the action of any morbid cause, and which can be removed only by a supply of that nourishment of which the system stands so much in need, and for which the digestive organs are so vigorously prepared. The loss of fluids during the night by insensible perspiration is said by Sanctorius to be twice as much as when awake.* This, and the loss by pulmonary exhala-

* Paris on Diet, p. 192.

tion, cause a corresponding demand for fluids in the morning, and hence the reason why our first daily meal is almost universally of a more fluid and less substantial description than any of the subsequent ones; while our active exertion and loss of solids during the day create a proportionate demand for a more substantial repast in the afternoon.

The function of absorption is thus at its highest pitch of activity in the morning; and if the body be exposed to miasma or other impurities, they will be much more easily and speedily absorbed by the skin, the pulmonary membrane, and the stomach before eating, than after the absorbents have been supplied with their legitimate food. This is the true theory of the greater susceptibility of infection and other poisonous influences when the stomach is empty.

So rapid is absorption from the stomach in the morning, that I have repeatedly seen *nine* tumblers of a saline mineral water taken at eight o'clock, and a very hearty breakfast finished within half an hour after the water was drunk! When in bad health three years ago, I observed almost equal expedition in my own person. I took half a pint of ass's milk at seven o'clock, and in consequence of coughing violently, was frequently seized with vomiting and retching within twenty minutes after taking it; but only twice or thrice was any portion of the milk perceptible, although the stomach was entirely emptied. This was even more remarkable than the other case, inasmuch as milk undergoes digestion, which water does not. In allusion to this rapidity of absorption, Sir Francis Head, in speaking of the quantity of the chalybeate waters swallowed of a morning at the Brunnens of Nassau, humorously remarks, that " one would think that this deluge of cold water would leave little room for tea and sugar; but, miraculous as it may sound, *by the time I got to my 'Hof,' there was as much stowage in*

the vessel as when she sailed; besides this, the steel created an appetite which it was very difficult to govern."*

In setting out early to travel, a light breakfast before starting is a great protection against colds and subsequent fatigue or exhaustion. I am quite aware that robust and healthy men can and do take much active exercise before breakfast, with apparent impunity, if not benefit, and I have often done so myself; but experience ultimately taught me that I became sooner exhausted on continuing the exertion through the day, than when I *began* by eating a little. During the first winter of my studies in Paris, I regularly attended the surgical visits at the Hotel Dieu, which began at six o'clock in the morning, and lasted till nine, or frequently half past nine. Not being then aware of the principle under discussion, I ate nothing till my return home; but I felt more weariness before the day was done than the mere exertion ought to have produced. At last, on noticing for a time the regularity with which many of the workpeople passing along paid their respects at a small shop, the only one then open, where fancy rolls were sold, along with wine and brandy, I thought of following their example, and trying how far a roll would add to my comfort, and impart additional vigour to the system. I soon found great reason to be pleased with the expedient, and discovered that I was not only less exhausted during the day, but more able to follow the lecture which concluded the visit, and in possession of a keener appetite for breakfast at my return, and ever since I have acted on the principle now inculcated, and with marked benefit. I was then astonished at the regularity with which the Parisian workmen seemed to take their morning dose, or *petit verre* of brandy, on their way to their labours.

* Bubbles from the Brunnens of Nassau, p. 46.

apparently for the very purpose of getting that wholesome energy which they ought to have sought in food alone.

During the prevalence of cholera, both here and on the Continent, it was often remarked that a large proportion of the attacks occurred early in the morning, in persons who had gone to bed apparently well. Chronic invalids and persons of a delicate habit of body are also familiar with the fact of the animal heat and general vigour diminishing towards morning. When reduced in strength by pulmonary complaints, I often passed the night in comparative comfort, sure to awake about five or six o'clock with a feeling of chill and absence of animal heat, which I could not dissipate till after receiving sustenance.

From these facts, the general inference is clearly warranted, that delicate persons ought to have some kind of food soon after rising, and that even those who are healthy will act wisely in not exposing themselves unnecessarily to fatigue, infection, or other morbid causes, without having previously supplied the wants of the system, either partially by a cup of coffee or tea, or entirely by a regular breakfast. Where fever, for example, is in a family, the danger of infection will be much greater to a person going directly from his own bed to the bedside of the patient, than to one who first takes the precaution of drinking were it only a cup of coffee. I have elsewhere noticed the safety which Captain Murray obtained for his crew in the West Indies, partly by attention to this rule; and have likewise referred to the experience of Sir George Ballingall even in our own climate.*

In boarding-schools for the young and growing, who require plenty of sustenance, and are often obliged to rise early, an early breakfast is an almost

* See the Principles of Physiology, &c., chap. iii.

indispensable condition of health. On the Continent, in similar establishments, seven o'clock is the common hour for breakfast, especially in summer.

In recommending what I conceive ought to be the general rule, let me not be understood as wishing to extend it so far as to advise those whose constitutions admit of two or three hours' activity before breakfast, to abandon what experience proves to be beneficial to them. My only wish is to help those who are in doubt as to choosing the plan which is most likely to be of advantage, and to relieve those who are already suffering from ignorance.

The morning meal being comparatively a light one, and the stomach being then in high vigour, digestion goes on briskly, so that appetite revives within a shorter time than after the more substantial dinner. Accordingly, in all nations and classes of society not perverted from the course of nature a longer interval than five hours rarely elapses between breakfast and dinner. Our forefathers dined at noon, as our sailors continue to do at the present day; and over no small portion of the Continent of Europe, the same primitive hour is still adhered to; and among the labouring population of Great Britain, one or two o'clock is the common dinner-hour, nine being that of breakfast. The universality of a mid-day meal among those who rise early, is itself a strong presumption in favour of its propriety, and of its being in harmony with the laws of the animal economy.

To prevent business from interfering unduly with digestion, it was formerly the custom in Edinburgh to shut up shops and counting-houses for two hours in the middle of the day; and in Switzerland, the same practice is or lately was prevalent. The members of the family being then assembled, relaxation and enjoyment take the place of the cares of the world; and the result is highly satisfactory. The

appetite is keen enough to induce them to eat with zest all that nature requires, while it wants the resistless force which is given by a fast of eight or nine hours. There is consequently slower mastication, less cramming, and a much earlier return of the aptitude for business; while at the same time the mental and bodily faculties are refreshed by the interruption of their accustomed labour, and the affections cherished by healthful domestic intercourse taking place before too much weariness is induced to permit of its being enjoyed. In England, such weariness is a very common occurrence. The parent and husband, exhausted by the eager pursuit of wealth during the livelong day, returns home in the evening jaded and harassed, and little able to take pleasure or interest in the enjoyments of his wife and family. Hence, indeed, too often arise indifference and unhappiness between those whom nature has formed as if on purpose to suit each other.

In enterprising commercial communities—in London and Liverpool for example—it is a common practice to hasten away to the counting-room immediately after an early breakfast; to remain there in active employment from nine or ten o'clock in the morning till six o'clock in the evening, and then to hurry home to a late dinner at six or seven o'clock; by which time the vital functions have become so far exhausted, as to create a strong desire for indulgence in something stimulating both in food and drink. If this desire be gratified, immediate relief is obtained, and a feeling of comfort pervades the frame; but nothing can be more erroneous than to regard this as a proof of the indulgence being beneficial. The organization soon gets accustomed to the stimulus; its susceptibility becomes impaired by the frequency with which the latter is administered; and in a short time indigestion is the inevitable consequence.

The evils attendant on this course of life are not unfrequently aggravated by the preposterous means resorted to for their prevention. Having some vague notion that *exercise* improves digestion, and not being at all aware that there is an improper as well as a proper time for taking it, many persons, after being exhausted by seven or eight hours' confinement to the counting-house, proceed to take a walk of four or five miles before going home to dinner, and thus utterly throw away the little strength that was left to them, and are filled with disappointment on finding their appetite and digestion worse than before.* Dr. Paris mentions the case of a clerk in a public office who brought upon himself all the horrors of dyspepsy and melancholy by following this plan. He breakfasted at nine, went to his office at ten, continued there till five, walked till seven, and then dined. He was cured in six weeks, by adopting a more rational regimen and dining at three o'clock.

Many females and delicate persons injure their powers of digestion by delaying their exercise till the system is too much exhausted to profit by it. In boarding-schools the same error is often committed from the desire which is felt to have all the lessons over before allowing any play.

As a general rule, then, not more than five hours ought to intervene between breakfast and dinner. If the mode of life be such as involves great activity in the open air, or the period of life be one of rapid growth or filling up (as during youth or convalescence from illness), the interval may with propriety be shortened; whereas, if the mode of life be sedentary, and unattended with much activity of nutrition, the interval may be considerably protracted without inconvenience. Much, also, ought to de-

* Respecting the proper regulation of exercise, see The Principles of Physiology, chap. iv.

pend on the natural rapidity or slowness of digestion. In some constitutions, chylification goes on so slowly that the individual can pass with ease eight or ten hours without food; whereas, in others, it is so rapid that a fresh supply becomes necessary in half the time. The proper rule in every case is, to take dinner at such an interval after breakfast as the return of healthy appetite indicates, whether that interval be longer or shorter than the average specified.

That, according to this rule, the *general* time for dinner ought to be somewhere about five hours after an ordinary breakfast, is evident from the almost universal return of appetite at the end of such an interval, and from the fact that many, through sheer inability to resist longer the wholesome cravings of nature, are in the regular practice of eating dinner at that time, but to save appearances give it the name of *luncheon* ; by which means they hold themselves entitled to the enjoyment of a second and more substantial dinner later in the day.

Invalids, dyspeptics, and all who, possessing vigorous digestion, wish to retain it, will do well to follow the intentions of nature, and observe the intervals which she has appointed. Those who disregard them, and still digest without difficulty, have reason to be grateful to Providence ; but they may rest assured that they will longer enjoy their privilege, and better evince their gratitude, by submitting their conduct to the ordinary laws of the animal economy, than by presuming too much on their supposed exemption from the salutary restraints of reason and experience.

Supposing nine o'clock to be the hour of breakfast, the natural dinner-hour would thus be two o'clock; and such, accordingly, is that sanctioned by the most extended experience, and which ought to be adhered to by all whose occupations will admit of

its observance, and who wish to enjoy the highest health of which they are susceptible.

Artificially arranged, however, as society now is, whole classes of the community find it impossible to dine till much later in the day. The question then comes to be—As we cannot follow the system laid down by nature, what is the next best to be done? Ought we to eat nothing till we can find time to dine at five, six, or seven o'clock; or ought we rather to take a light meal at the natural time, about one or two o'clock, and reserve our appetite chiefly for the substantial meal which we have leisure to digest?

The principle in virtue of which digestion is interrupted by bodily or mental labour occurring after a full meal, having been already sufficiently explained, it needs scarcely be added, that the second is the better plan; and moreover, that by leaving the stomach too long empty, we risk impairing its functions and weakening the system.

When dinner cannot be taken earlier than seven or eight hours after breakfast, most people will find it advantageous to partake of some slight refreshment in the meantime—enough to blunt the keenness of appetite, but not entirely to destroy it. When the individual is exposed to much bodily exertion in the open air, or is at the period of rapid growth, a portion of animal food, or an ordinary luncheon, taken in moderation, may be allowable, and even requisite; but where the habits are sedentary and the constitution formed, a bit of bread or biscuit and a glass of water will be far more serviceable. Many people, from want of any better occupation, make a pastime of filling their stomachs every forenoon at the pastry-cook's, with as little regard to its powers and necessities as if digestion were meant merely as an appendage to taste; and think themselves entitled to complain of their defective appetites, and the great discomfort which attends the subsequent ingestion of a heavy dinner.

To relieve the weakness, arising not from exhaustion, but from the oppression of satiety, they resort to wine, as if by adding fuel to the fire they could hope to extinguish the flame!

Even in fashionable life the superiority of nature's arrangements over those of man is so far acknowledged, that it is an almost universal rule for children to dine in the middle of the day; and there cannot be a doubt that the practice is attended with manifold advantages to the young, although, as regards their moral training, these would be greatly increased were they to associate at meals with their parents, instead of being left entirely to the company and management of servants.

Supposing it to be made an imperative condition of our social existence that we shall rise after midday, and not go to bed till a late hour in the morning, the present fashion of dining at seven or eight o'clock becomes much more rational than is commonly imagined by those who declaim against it without regard to the concomitant circumstances. It is, no doubt, most absurd and hurtful for a man who rises at seven or eight o'clock, breakfasts at nine, and goes to bed at eleven, to delay dining till seven in the evening; but it by no means follows that seven is a bad dinner-hour for a person who rises at twelve or one o'clock, breakfasts at two, and goes to bed at three in the morning. The interval between the breakfast at one and dinner at seven o'clock, is the same as between breakfast at nine and dinner at three, namely, six hours—which is little more than enough. The error lies, not in the hours chosen for meals, but in the utter perversion of the whole system of living, by which night is converted into day, and the business of life is postponed five or six hours beyond the time appointed by the Creator for its performance. So far from the late dinner being hurtful in such circumstances, it is only the stimulus and support which it affords

that enables the victims to withstand the fatigue even for a single week.

No one has a stronger sense of the injury done to society by the wide departure from the laws of nature by which its present arrangements are characterized, and no one is more willing to contribute all that is within his power to reform them, than the writer of these pages; but let the whole system be amended, and do not limit the reform simply to altering the hour of dinner, while the conditions which have led to the existing arrangement are left unchanged.

In the country, even among the higher classes, a greater approximation to the order of nature is observable than in towns. The inducements to sleep away the day and to be awake during the night are diminished; bodily exercise and exposure to the open air are more indulged in; the appetite becomes keener, and digestion more vigorous; and, as a necessary result, meals are taken an hour or two earlier. But, throughout all these changes, the general feature of having some kind of refreshment, either luncheon or dinner, within four, five, or six hours after breakfast, may be pretty accurately traced.

If business admits of it, and the person can then command two hours of relaxation, the best plan, unquestionably, is to dine about five or six hours after breakfast. But if this be impossible, and active exertion of mind or body must be continued for several hours longer, it will be far better to eat some light refreshment in the forenoon, and to postpone dinner not only till business is over, but till half an hour or an hour's repose has allowed its attendant excitement or fatigue to subside. By this means the stomach will enter upon its duties with vigour, and the dinner be digested with greater comfort and despatch, than if we sit down to table the moment our work is finished. In this way, the tedious quarter of an hour preceding the announcement of

"*dinner*" is far from being lost to the subsequent digestion.

Very few people, indeed, can eat a good dinner and return immediately to bodily or intellectual labour with continued impunity. On this account, actors, for example, whose vocation requires exertion of both mind and body, almost all either dine very early, or take their chief meal at night on their return home, the latter being the more common practice. Students, literary men, and persons intently engaged in business, are very apt to damage themselves by neglecting relaxation at and after meals.

The time for dinner ought, then, to vary according to the constitution, occupations, and mode of life of the individual; and the nearer the whole of these can be made to approximate to the intentions of nature, the more vigorous will be the powers of digestion, and the more complete the nutrition of the body; and, consequently, the more easily will the stomach recover the tone which it may have lost from previous mismanagement. In attempting to cure indigestion, notwithstanding the most scrupulous adherence to the rules given for the proper selection of food, if we set at defiance all the other conditions of healthy digestion, our adherence will be of little avail. Whereas, if we fulfil the laws of our constitution, by rising from bed in the morning, obtaining a healthy appetite and lively circulation by the regular exercise of the various functions of mind and body in a free and pure atmosphere, eating moderately, and enjoying social relaxation after our meals—digestion will be so far strengthened, that no very rigid observance of any particular kind of diet will be necessary; it being always understood, however, that we shall not exceed in quantity what the wants of the system require.

It would be a waste of time to discuss gravely whether *tea* and *coffee* ought to be allowed in the

evening. Custom has already decided the point, and experience has shown that, taken in moderation, they rather promote than impede digestion. When the dinner is early—say at one, two, or three o'clock—a light meal of tea and bread in the evening is very suitable, as it saves the necessity of eating a heavier supper. If the individual be accustomed to much active exertion in the afternoon, so as to cause considerable waste in the system, and especially if he be young, a small addition of animal food may be made with great propriety to the evening meal. But, on the other hand, when the dinner is late, or little exertion is incurred after it, tea or coffee ought to be used more as a diluent than as a meal.

The French drink a single cup of strong coffee without cream immediately after dinner, and find digestion go on all the better for it. It acts as a strong stimulant, and certainly increases the feeling of comfort for the time. Like all other stimulants, however, its use is attended with the disadvantage of exhausting the sensibility of the part on which it acts, and inducing weakness. This inconvenience is not felt to the same extent, indeed, after coffee as after spirits, but still it exists; and it is infinitely better that the stomach should be brought up to do its own work ungrudgingly, than taught to depend upon assistance from without; and, therefore, such assistance ought to be reserved for the relief of occasional exhaustion, instead of being resorted to as a regular indulgence. The French partake of a much greater variety of dishes at one meal than we are accustomed to do, and may thus require the aid of coffee to keep the stomach from actual rebellion. But the way to obviate this necessity is obviously to eat a more simple and more moderate meal.

A great deal has been said and written about the properties of tea and coffee as articles of diet. At

present, however, we have to do with them only as elements of a third meal, and must reserve the discussion of the other branch of the subject to a future opportunity.

In determining whether a third meal ought to be taken, either as tea or as supper, the general principle already laid down will be very useful. If dinner be sufficiently early to admit of digestion being completed, and the stomach afterward recruited by repose, and if the mode of life be active, so as to occasion a natural return of appetite before the day is done, the propriety of a third meal cannot be questioned. But if dinner be late, and there be too short an interval between it and bedtime to admit of digestion being finished and the appetite renewed, then every additional mouthful swallowed is sure to do mischief. The farmer who dines at two o'clock, for example, and, after walking about his fields for three or four hours in the afternoon, comes home in the evening with a genuine and undeniable appetite, has a legitimate right to an additional supply of wholesome food before betaking himself to his couch; because a sufficient interval has elapsed to allow the stomach to recover itself from the labour of digesting his dinner, and the continued waste of the system requires to be replaced. In like manner, the man of fashion, who dines at seven o'clock, and frequents assemblies till three or four in the morning, is well entitled to some kind of supper about one or two o'clock, and could scarcely get through his laborious duties without farther sustenance from either food or wine, or both. Even in his case, six hours may thus intervene between dinner and supper; and we know that, on an average, digestion is finished in four or five hours. The chief difference between him and the farmer is, that the farmer reaps health and sound digestion from adhering in his hours to the institutions of the Creator, and that the man of fash-

ion impairs his constitution and enfeebles his digestion—less by the improper intervals at which he eats, than by his wide departure from the order of nature in the hours which he observes.

If, in adopting the precepts of ultra-temperance, we dine early, live actively, and go to bed with the stomach entirely empty, we *may* sleep, but our dreams will scarcely be more pleasant, or our sleep more tranquil, than if the stomach were overloaded. A gnawing sense of vacuity is felt in such circumstances, which is apt to induce restlessness, and nervous impatience and irritability. I have repeatedly seen these unpleasant symptoms dispelled, and sound sleep obtained, by no other prescription than a cupful of arrow-root an hour or two before bedtime.

Except in early life, and in the case of those who lead a very laborious existence, and observe very early hours, supper as a fourth meal is altogether superfluous, at least where any thing is eaten at tea. In youth, waste, growth, and nutrition are so active, that a moderate supper is often indispensable, especially when the muscular system is freely exercised in the open air. But it ought to be of a light nature, and taken at least an hour or two before going to bed. If dinner be taken early, and tea be used in the afternoon, not as a meal, but merely as a diluent, a light supper will be very proper.

In short, the grand rule in fixing the number and periods of our meals is, *to proportion them to the real wants of the system, as modified by age, sex, health, and manner of life, and as indicated by the true returns of appetite ;* and, as an approximative guide, to bear in mind that, under ordinary circumstances of activity and health, three, four, or five hours are required for the digestion of a full meal, and one or two hours more of repose before the stomach can again become fit for the resumption of its labours.

If the meal be temperate and the mode of life natural, digestion will be completed in from three to four hours, and one hour of rest will serve to restore its tone; but if the quantity of food be great, or the general habits be those of indolence, digestion may be protracted to five or six hours, and two or more be required for subsequent repose. It is therefore utterly absurd and inconsistent with the laws of nature to pretend, as many writers have done, to lay down rules which shall apply to every individual and to every variety of circumstances. As already mentioned, rules applicable to classes may be prescribed, because there is a considerable similarity in the circumstances of all the individuals comprehended in it; but even there numerous exceptions must occur, which can be judged only by the standard of the individual constitution.

The Creator indeed has obviously never intended that we should be bound down to the rigid observance of a very strict order in diet; but, to fit us for the ever-varying circumstances in which we are placed, has wisely and benevolently allowed us considerable latitude; and made appetite to vary in the extent and earnestness of its demands in proportion to the waste to which we are subjected for the time. It is astonishing how rapidly a healthy frame accommodates itself even to great changes, when temperance is duly observed, and a proper regard is paid to the intimations of appetite.

In suiting my own mode of life to the circumstances under which I have at various times been placed, I have repeatedly, even as an invalid, made sudden changes in the hours of eating, with no further injury than temporary discomfort; but then I always adhered to the general principles above insisted on. It was by some of these experiments that my attention was first drawn to the great influence of the accessary conditions in retarding or promoting digestion. At one time, on altering my

place of residence from Aix to Marseilles, I changed at once from breakfasting at eight o'clock, dining at two, and taking tea in the evening, to breakfasting at eleven, and dining at six. For the first few days I felt uncomfortable in waiting so long in the morning; but by following the plan of taking a small cup of coffee and a crust of bread soon after rising, and attempting no active bodily exertion till after breakfast, every feeling of inconvenience ceased, and the system adapted itself to the change as completely as if it had never been accustomed to any thing else. Three months afterward I embarked on the Mediterranean, and again passed at once to breakfasting between seven and eight o'clock, dining about noon, and taking tea in the evening, which I continued to do for some time after arriving in Italy. On my way home the hours of eating were never two days the same, and yet I did not suffer. If breakfast was early, I ate it with relish. If it was late, I had recourse to a biscuit, or some dried fruit, early in the morning, to sustain the system in the meantime, and was ready for it when it came. In the same way, if dinner was to-day at one o'clock, I took it when it was offered, and had recourse to some refreshment in the evening: if to-morrow it was postponed till eight o'clock, which sometimes happened, the refreshment came in the forenoon, and a moderate meal was taken in the evening.

In these changes, however, it will be remarked, that the laws of digestion were in reality much less infringed upon as to time than one might imagine from merely hearing that I dined one day at noon and the next day at eight o'clock in the evening. At whatever hour the meal was taken, the real wants of the system were supplied when they manifested themselves in the form of appetite, and the requisite intervals were observed. If a substantial breakfast was taken at eight o'clock, then a corre-

sponding interval elapsed before another meal followed at one or two. If, again, the morning allowance was trifling, then the real breakfast followed at an interval correspondingly short, namely, at eleven o'clock. So also with dinner. And if dinner was at one o'clock, tea followed at the distance of six or seven hours; whereas, if it came at six or seven o'clock, a refreshment preceded and nothing followed it, and the result was comfort and sound digestion. If, however, we yield unguardedly to the impulse of appetite in travelling, and eat and drink plentifully instead of temperately, no arrangement of hours that we can make will render our situation either pleasant or healthful.

While, therefore, it seems to be obvious beyond a doubt, that those who live according to the laws of nature and begin their activity with the morning, should breakfast betimes, dine early in the day, and take a lighter meal in the evening, and that those who do so will reap a reward in health and vigour of mind and body unattainable to the same extent by those who live differently, and convert night into day,—it would be not less hurtful than absurd to prescribe the same hours for meals to all, whatever their hours of activity, and whatever their modes of life; and I cannot help thinking, that it is the preposterous attempt to generalize too much, which, losing sight of true principle and the modifications which it requires in individual cases, has brought dietetic precepts into disrepute, and led to the belief that the rules laid down are merely arbitrary assumptions, resting on no solid foundations in the human constitution, or in the designs of our Creator.

As experience is the best guide to knowledge, I may be allowed to add, that, when travelling on the continent in health and strength, I suffered more from feverish fatigue and stomachic discomfort, induced by ignorant infringement of the laws of diges-

tion, than I ever afterward did, even from more continued exertion when travelling as an invalid under a better regulated system of diet. I did not, in either case, make any exception to the meals which awaited our arrival at the inns, or to the hours at which they were served. The chief difference was, that, when well, I ate till my appetite was fully satisfied, under the notion that, in travelling, a full diet is necessary to enable one to withstand the fatigue ; and that, as an invalid, on the other hand, I ate more sparingly, and, if the regular meal was much later than usual, had recourse to biscuit, fruit, or a slice of cold meat, as an intermediate refreshment, to prevent the stomach becoming exhausted from too long a fast. Following the dictates of experience, I have long adhered to the latter plan, and am convinced that few who have tried both will long prefer the former.

CHAPTER II.

ON THE PROPER QUANTITY OF FOOD.

Quantity to be proportioned to the wants of the system.—Appetite indicates these.—Cautions in trusting to appetite.—General error in eating too much.—Illustrations from Beaumont, Caldwell, Head, and Abercrombie.—Mixtures of food hurtful chiefly as tempting to excess in quantity.—Examples of disease from excess in servant-girls from the country, dressmakers, &c.—Mischief from excessive feeding in infancy.—Rules for preventing this.—Remarks on the consequences of excess in grown persons.—Causes of confined bowels explained—And necessity of fulfilling the laws which God has appointed for the regulation of the animal economy inculcated.

THE next important step in the regulation of diet is to determine the QUANTITY which ought to be eaten.

To ensure easy digestion and sound health, the quantity of food ought always to be proportioned to the wants of the system ; but this can be done only by a constant reference to the individual's constitution and circumstances, and not by attempting to lay down any standard as admitting of universal application.

We have seen that, where waste is great and growth active, an abundant supply of food is required, and that, in accordance with this relation, it is in such circumstances that the desire for food is most keenly felt. Generally speaking, appetite is a safe guide as to quantity; but, in following its dictates, we must take special care neither to eat so fast as to prevent it from giving timely intimation that we have had enough, nor to confound the mere gratification of *taste*, or the yearning of a vacant mind, with the natural craving of unsatisfied want. Dr. Beaumont's remarks on this subject are characterized by so much soundness of judgment, that no apology can be required for soliciting the attention of the reader to the following very pertinent extract from his work.

"There is no subject of dietetic economy," says Dr. Beaumont, "about which people err so much, as that which relates to *quantity*. The medical profession, too, has been accessory to this error, in giving directions to dyspeptics to eat until a sense of satiety is felt. Now this feeling, so essential to be rightly understood, never supervenes until the invalid has eaten too much, if he have an appetite, which seldom fails him. Those even who are not otherwise predisposed to the complaint, frequently induce a diseased state of the digestive organs by too free indulgence of the appetite. Of this fact, the medical profession are, generally, not sufficiently aware. Those who lead sedentary lives, and whose circumstances will permit of what is called free living, are peculiarly obnoxious to these com-

plaints. By paying particular attention to their sensations during the ingestion of their meals, these complaints may be avoided. There appears to be a sense of perfect intelligence conveyed from the stomach to the encephalic centre, which, in health, invariably dictates what quantity of aliment (responding to the sense of hunger and its due satisfaction) is naturally required for the purposes of life; and which, if noticed and properly attended to, would prove the most salutary monitor of health, and effectual preventive of disease. It is not the sense of *satiety*, for this is beyond the point of *healthful* indulgence, and is nature's earliest indication of an *abuse* and *overburden* of her powers to replenish the system. It occurs immediately previous to this, and may be known by the pleasurable sensations of *perfect satisfaction, ease, and quiescence of body and mind.* It is when the stomach says *enough*, and is distinguished from satiety by the difference of the sensations,—the former feeling *enough*—the latter *too much.* The first is produced by the timely reception into the stomach of proper aliment, in exact proportion to the requirements of nature, for the perfect digestion of which a definite quantity of gastric juice is furnished by the proper gastric apparatus. But to effect this most agreeable of all sensations and conditions—the real Elysian satisfaction of the *reasonable* epicure—timely attention must be paid to the preliminary processes, such as thorough mastication and moderate or slow deglutition. These are indispensable to the due and natural supply of the stomach, at the stated periods of alimentation; for if food be swallowed too fast, and pass into the stomach imperfectly masticated, too much is received in a short time, and in too imperfect a state of preparation, to be disposed of by the gastric juice.

"The quantity of gastric juice, either contained in its proper vessels or in a state of preparation in the

circulating fluids, is believed to be in exact proportion to the proper quantity of aliment required for the due supply of the system. If a more than ordinary quantity of food be taken, a part of it will remain undissolved in the stomach, and produce the usual unpleasant symptoms of indigestion. But if the ingestion of a large quantity be in proportion to the calls of nature, which sometimes happens after an unusual abstinence, it is probable that more than the usual supply of gastric juice is furnished; in which case the apparent excess is in exact ratio to the requirements of the economy, and never fails to produce a sense of quiescent gratification and healthful enjoyment. A great deal depends on habit in this respect. Our western Indians, who frequently undergo long abstinence from food, eat enormous quantities when they can procure it, with impunity."*

If the purposes for which eating is necessary be kept in mind, the keen appetite and vigorous digestion observable in growing youths, and in those who undergo much active exercise in the open air—and the weaker appetite and feebler digestion observed during the middle period of life, especially in persons of sedentary habits—will appear to be in strict harmony with the wants of the system in the respective circumstances. But from no attention being paid by either the old or the young to the principle by which the supply of nourishment ought to be regulated, and the haste with which every one labours to appease the cravings of hunger, it may be affirmed, as a general fact, that mankind eat greatly more than is required for their sustenance; and the indigestion thereby induced is a salutary provision of nature to prevent the repletion which would otherwise ensue.

Sir Francis Head, in his humorous book entitled

* Beaumont's Observations, &c., p. 63.

Bubbles from the Brunnens of Nassau, by an Old Man, expresses his astonishment at the "enormous quantity of provisions" which the invalids and sojourners at these watering-places "so placidly consume;" and, after noticing "the heavy masses which constitute the foundation of the dinner, and the successive layers of salmon—fowls—puddings—meat again—stewed fruit—and, lastly, majestic legs of mutton—which form the lighter superstructure," he adds :—"Nothing which this world affords could induce me to feed in this gross manner. The pig which lives in his sty would have some excuse, but it is really quite shocking to see any other animal overpowering himself at mid-day with such a mixture and superabundance of food" (p. 71). In another page he returns to the subject, and quaintly enough remarks, "that almost every malady to which the human frame is subject is, either by high-ways or by-ways, connected with the stomach; and I must own, I never saw a fashionable physician mysteriously counting the pulse of a plethoric patient, or with a silver spoon on his tongue, importantly looking down his red inflamed gullet (so properly termed by Johnson 'the meat-pipe'), but I feel a desire to exclaim, 'Why not tell the poor gentleman at once—Sir, you've eaten too much, you've drunk too much, and you've not taken exercise enough!' That these are the main causes of almost every one's illness, there can be no greater proof than that those savage nations which live actively and temperately have only one great disorder —death. The human frame was not created imperfect—it is we ourselves who have made it so; *there exists no donkey in creation so overladen as our stomachs; and it is because they groan under the weight so cruelly imposed upon them, that we see people driving them before them in herds to drink at one little brunnen*" (p. 91–2).

Our supposed "Old Man" is by no means singular

in his opinions. The celebrated Roman physician Baglivi, who, from practising extensively among Catholics, had ample opportunities of observation, mentions that in Italy an unusually large proportion of the sick recovered during Lent, in consequence of the lower diet which is then observed as part of the religious duties. This is a striking fact, and gives unequivocal proof, not only in favour of temperance, but in evidence of the assertion that excess in quantity is a prevailing error in society.

Professor Caldwell, of Transylvania University, Kentucky, in one of his vigorously-conceived and very instructive essays, inveighs eloquently against the intemperance of his countrymen in eating as well as in drinking, and tells them that one American consumes as much food as two Highlanders or two Swiss, although the latter are among the stoutest of the race. "Intemperate eating," says he, "is perhaps the most universal fault we commit. We are all guilty of it, not occasionally, but habitually, and almost uniformly, from the cradle to the grave. It is the bane alike of our infancy and youth, our maturity and age. It is infinitely more common than intemperance in drinking; and the aggregate of the mischief it does is greater. For every reeling drunkard that disgraces our country, it contains one hundred gluttons—persons, I mean, who eat to excess and suffer by the practice." How, indeed, he afterward exclaims, can the case be otherwise, while children and youth are regularly taught, hired, bribed, or tempted, "to overeat themselves from their birth! Do you ask me for evidence in proof of this charge? Go to our dining-rooms, nurseries, fruit-shops, confectionaries, and pleasure-gardens—go even to sick-rooms—and you will find it in abundance. You will witness there innumerable scenes of gormandizing, not only productive of disease in those concerned in them, but in many instances offensive to beholders. The frightful mess often

consists of all sorts of eatable materials that can be collected and crowded together; and its only measure is the endurance of appetite and the capacity of the stomach. Like the ox in rich pasture-ground, or the swine at his swill-trough, men stow away their viands until they have neither desire nor room for any more. I do not say that such eating-matches always and everywhere occur among us. But I do say that they occur too frequently, and that they form fit subjects for caricature pictures by European tourists of our domestic manners. I add, however, that similar scenes present themselves in every country I have visited, where provisions are abundant and cheap."*

This is a strongly-drawn picture, but, with a modification in degree, it is perhaps not less applicable to our own and other European countries than to the United States. The "Old Man's" description of German feeding is, in its main features, essentially the same; and, so far as my observation and experience go, it is only in a less degree that we fall short of our brethren in America. As a general rule, we also exceed, though not to the same extent. This is owing partly to our more advanced civilization, and partly to the greater difficulty of procuring the means of excess; and if I have resorted to Germany and the United States for the most striking illustrations of the principle, it is not from want of examples at home, but because we are so much more alive to the errors of our neighbours than to our own, that the principle involved in their commission will be more readily recognised when pointed out in them than when its perception is made to imply condemnation of ourselves.

It is a trite observation, that medical men are

* Transylvania Journal of Medicine for September, 1832, p. 313. See also Dr. Caldwell's excellent Thoughts on Physical Education, and the True Mode of Improving the Condition of Man; reprinted for A. and C. Black, Edinburgh, 1836.

constantly exclaiming against the eating propensities of their patients, and inculcating the practice of temperance. One of the most eminent physicians of the present day says : " I believe that every stomach, not actually impaired by organic disease, will perform its functions if it receive reasonable attention ; and when we consider the manner in which diet is generally conducted, both in regard to quantity and to the variety of articles of food and drink which are mixed up into one heterogeneous mass, instead of being astonished at the prevalence of indigestion, our wonder must rather be that, in such circumstances, any stomach is capable of digesting at all. In the regulation of diet, much certainly is to be done in dyspeptic cases by attention to the quality of the articles that are taken ; but I am satisfied that *much more depends upon the quantity* ; and I am even disposed to say, that the dyspeptic might be almost independent of any attention to the quality of his diet, if he rigidly observed the necessary restrictions in regard to quantity."* The latter opinion is obviously borne out by Dr. Beaumont's observation of the power of digestion being limited by the amount of gastric juice which the stomach is capable of providing—an amount varying with the wants of the system, and consequently with the mode of life.

Cornaro, Cheyne, and others, have most absurdly attempted to determine a standard quantity of food for all mankind, and have fixed it at the lowest possible limit. The very attempt, however, is inconsistent with the laws of the animal economy ; since the supply required must necessarily vary not only according to the age, sex, and constitution of the individual, but according to the mode of life and the circumstances by which he is surrounded ; and it would be, therefore, not less injurious than un-

* Abercrombie on Diseases of the Stomach, &c., 1st ed., p. 72.

natural for any one to adhere to the same invariable proportion.

Mixtures of different kinds of food are strongly condemned by almost all writers on dietetics, as injurious to digestion. So far, however, as my observation goes, they produce mischief much more by the *inducement to excess in quantity* which variety affords, than by the mere mixture of different substances. In a healthy stomach, indigestion is rarely if ever induced by eating several kinds of food at one meal, provided the total amount consumed be not beyond the wants of the system, and do not exceed the due proportion to the quantity of gastric juice which the stomach is able to provide. When only one dish is partaken of, there is less temptation to exceed in quantity than where several are tried.

The first intimations of satisfied appetite are unquestionably the best warning we can have when to stop eating. If we do not go beyond this point, the subsequent sensations are pleasurable and invigorating, and, after a brief interval, we are perfectly disposed to return to active exertion. But, if we eat more than enough, fulness and oppression are almost immediately experienced, and a considerable time must elapse before either mind or body can effectually resume its activity.

Where, either from long over-indulgence or other causes, the appetite cannot be safely followed as a guide in regulating the quantity of food, we shall not err very far if we proportion our meals to the amount of the preceding exercise. When this has been active and in the open air, and waste has consequently been considerable, a liberal allowance of food will be more easily digested than perhaps half the quantity would be after a week's inaction. Hence it is a great error to devour the same quantity of food daily, whatever our mode of life and bodily exertion may be; and yet nothing is more

common than to see persons who have passed from a life of varied activity to one of a purely sedentary nature, continue to eat—merely because they have been accustomed to it—as much food as if they were still engaged in constant bodily exertion. Many females of the higher and middle classes, who scarcely ever stir out of doors except to church, nevertheless make as hearty meals twice or thrice a day as if they were undergoing pretty severe exertion; but they sooner or later reap their reward in bad digestion and annoying nervous disorders.

In towns we often observe the bad effects of overfeeding in young female servants recently arrived from the country. From being accustomed to constant exercise in the open air, and to the comparatively innutritious diet on which the labouring classes subsist, they pass all at once, with appetite, digestion, and health in their fullest vigour, to the confinement of a house, to the impure atmosphere of a crowded city, and to a rich and stimulating diet. Appetite, still keen, is freely indulged; but waste being diminished, while nutrition is increased, fulness is speedily induced, followed in its turn by inflammatory disease or fever, which sometimes cuts short life, where, with better management, health might have been preserved for years. In many instances, again, life is saved by the digestive powers being the first to give way, and refusing either to receive or to concoct the same quantity of aliment as before, and the patient then escapes with the minor evils of protracted dyspepsy or indigestion.

The operation of the same principle is still more conspicuous in girls sent from the country to the work-rooms of fashionable milliners and dressmakers in the larger towns. Transferred at once from activity in the open air to confinement all day, and often to a late hour at night, at a sedentary

occupation, where there is scarcely even the means of changing their position, and much less of enjoying active muscular exercise, and where, consequently, there is little waste, the digestive powers speedily give way, because less food is now required to repair the diminished loss. If the individual adapts her eating to her change of circumstances, she may escape severe disease; but if, as generally happens, from pure ignorance, she continues to eat to the same extent as before, headaches, sickness, bilious disorder, and indigestion will be among the smallest of her evils, and she will have reason to be thankful if she does not become the victim of confirmed bad health. In establishments of this description, the provision of the means of exercise, even by dumb-bells, shuttlecock, or otherwise, in a large room with open windows for a few minutes, several times a day, would not only prevent much suffering, but even repay itself in an economical point of view, by producing an increased aptitude for work, and less frequent absence on account of illness. In these days of wide-spreading philanthropy, considerations of this kind ought to be more attended to.

The necessity of proportioning the supply of food to the expenditure incurred, and to the mode of life, is still further illustrated in the case of individuals changing from an agricultural or other employment carried on in the open air in the country, and involving no very great bodily labour, to one of a mechanical kind carried on in an impure atmosphere in a city, and requiring a severe and continued muscular exertion. It is a matter of experience, for example, that the stout young men from the country, who are generally selected as apprentices for the laborious occupation of letter-press printing, almost uniformly break down during the first ten or twelve months; and it is only after some years' training that they are able to withstand the fatigue. The vitiated atmosphere in which they work has some share in

producing this result; but the chief cause is, undoubtedly, the inadequacy of their ordinary diet to repair the great expenditure of muscular energy to which they are habitually subjected, and for which they have not been previously prepared. In the office where this volume is printed, four strong and healthy lads were engaged last summer as pressmen, and put to work along with an equal number of experienced men. Already (February) every one of the former has been laid up from sickness for weeks, although the whole of them are of the most sober and steady habits; while not one of the older and more experienced men has felt any inconvenience from his exertions. This very instructive fact is also deserving of attention, as corroborating what I have elsewhere said in regard to the necessity of proper management during the period of transition from youth to manhood—a period during two or three years of which more good or more mischief may be done to the human constitution, than during almost any other ten years of life.* That, in times past, pressmen have suffered at least as much from their own mismanagement as from the nature of their employment, is rendered probable by their proverbial dissipation. In utter ignorance of the structure and laws of the animal economy, they not unnaturally sought to relieve the exhaustion under which they suffered by the stimulus of spirituous and other intoxicating liquors, instead of seeking it —where only it can be effectually obtained. and at a cheaper rate—in a more wholesome and nourishing diet. It is gratifying to perceive, however, that in this, as in many other trades, the progress of knowledge is already leading to the prevalence of more rational ideas, and to the consequent formation of better habits.

* Principles of Physiology, &c., chaps. vii. and x.

There is no period of life during which it is of greater importance to follow the intentions of nature in the regulation of diet, both as to quantity and quality, than during the earliest part of childhood; for at no period is the neglect of them more fatal. Surprise is sometimes expressed at the number of children who are carried off before completing their first or second year; but when we consider the defective education, and entire ignorance of the human economy, not only of the nurses and servants, to whose care the young are intrusted, but of the parents themselves, our wonder ought to become greater that so many survive than that so many die. There is perhaps not one mother in ten thousand who, before becoming such, has ever inquired into the nature and wants of the newly-born infant, or knows on what principles its treatment ought to be directed; and hence the hurtful and superstitious notions of the human economy which still linger in the nursery, long after they have ceased to prevail in the world of science.

Those whose opportunities of observation have been extensive, will agree with me in opinion, that nearly one half of the deaths occurring during the first two years of existence are ascribable to mismanagement and to errors in diet. At birth, the stomach is feeble, and as yet unaccustomed to food. Its cravings are consequently easily satisfied, and frequently renewed. A healthy infant seeks the breast with avidity, but sucks a little at a time. It leaves an interval for thoroughly digesting the little which it has swallowed; after which its appetite revives, and a fresh supply is demanded in a language which no mother can misinterpret. During the first months, appetite ought to be the mother's guide in offering the breast; and if she know how to read the expression of her infant aright, she will want no other. At that early age, there ought to be no fixed time for giving nourishment. The stomach cannot be

thus satisfied. In one child digestion may be slow, and the interval be consequently too short; in another it may be quick, and the interval too long. But the active call of the infant is a sign which needs never be mistaken, and none else ought to be listened to.

Many mothers consider every expression of uneasiness as an indication of appetite, and whenever a child cries they offer it the breast again, although ten minutes may not have elapsed since its preceding repast. Nothing can be more injurious than this custom. It overloads and oppresses the stomach,—excites griping and bowel-complaints, restlessness and fever,—and not unfrequently leads to fatal diseases in the brain. It does harm also by withdrawing the mother's notice from the real source of uneasiness.

It is astonishing, indeed, with what exclusiveness of understanding eating is regarded even by intelligent parents as the grand *solatium*, or *panacea* for all the pains and troubles which afflict the young. If a child falls over a stone and bruises its leg, its cries are immediately arrested by a sugar-biscuit stuffed into its open mouth. If its temper is discomposed by the loss of a toy, it is forthwith soothed by an offer of sweetmeats, the ultimate effect of which is to excite colicky pains in its bowels, which are worse than the original evil, and for which, in their turn, it is presented with "nice peppermint drops," or some other equally pleasant antidote. Because the mouth is open when the child is crying, and the mouth leads to the stomach, parents jump to the conclusion that it is open for the purpose of being filled, and proceed to cram it accordingly; forgetting all the while that the mouth leads also to the windpipe, and may be open for the admission of air to the lungs as well as of food to the stomach, and that if they stuff it with cake or pudding when it is open only for the reception of

air, they run the risk of suffocating the little innocent when their only wish is to sooth him. Everybody must have seen fits of convulsive cough induced by fragments of food being drawn into the windpipe in such circumstances.

To confound crying and the expression of pain with the cravings of hunger, is far from being a matter of indifference to the child. If food be given when it wishes only to be relieved from suffering, the offending cause is left in activity, and its effects are aggravated by the additional ill-timed distention of its stomach. But so far is this important truth from being sufficiently impressed on the minds of parents and nurses, that nothing is more common, when the infant refuses to swallow more, but still continues to cry, than to toss it in the nurse's arms, as if on purpose to shake down its food, and then resume the feeding. And in such attempts it is too true that the perseverance of the nurse often gets the better of the child, and forces it at last to receive the food at which it really loathes.

"Let appetite, then, be the only rule, but allow it to appear, and do not attempt to provoke it. The breast ought not to be offered to the infant; it is for him to seek it. He has little need of sucking who takes it with indifference, or as if he were conferring a favour. He who is hungry acts very differently; all his gestures express clearly the want and the desire; his eye follows his nurse, and tries to interpret her every movement. If he is crying, his cries cease at her approach, and smiles replace his tears. If he is offered the breast, he seizes it with ardour, and the mother yields to a natural want." But it is far otherwise when real appetite is wanting, and "it then becomes an act of cruel perfidy to tempt the infant by the offer of the breast. How can it be expected to resist the temptation, when the adult, whose appetite is already satisfied at the festive board, yields to the solicitations of the host,

and gorges himself with aliments which he cannot digest?"*

The same intelligent author remarks, that the lower animals instinctively avoid this error, and, instead of offering suck too often, rather allow themselves to be strongly solicited before yielding to the wishes of their young. By this provident arrangement, the latter are protected from the evils of too frequent eating. Many mothers imagine that milk is so bland a fluid that it is impossible for an infant to take too much of it; but the fallacy of the notion is exposed when we recollect that milk is coagulated the moment it reaches the stomach, and that the real subject of digestion is *curd*—a substance not quite so light as milk has the appearance of being.

The grand rule, then, during the early months of infancy, is to satisfy the clearly indicated and ascertained wants of the child, but neither to confine it to regular hours, nor to offer it food when it is crying solely from pain and not from hunger. When the system has become more developed, and the stomach accustomed to the exercise of its functions, regularity in the distribution of its meals may be gradually and beneficially introduced: because, in the animal economy, there is a natural tendency to periodicity, which greatly facilitates the formation of proper habits.

From the sudden change attending the introduction of the infant into the world, the many new sensations which it begins to feel, and the non-secretion of milk in the mother's breasts for some hours after delivery, it seems to have been intended by nature that both parent and child should have some time for repose before a supply of food should be required by the one or furnished by the other. But, through pure ignorance and mistaken kindness, many nurses, imagining themselves wiser than na-

* Londe, Elemens d'Hygiène, vol. ii., p. 161.

ture, and conceiving that the newly-born infant must of necessity be starving after what they consider a nine months' fast, hasten to fill its stomach with gruel or some other food. Not unfrequently, severe indigestion is thus induced at the very outset, which, in a delicate child, may be sufficient to lay the foundation of much suffering and bad health.

On the general principle that no physical want ever exists without the means of supplying it having been provided by nature, we may safely infer that, in ordinary cases, the secretion of milk will be begun before the infant can possibly require it; and to counteract this arrangement is to set ourselves up in direct opposition to the Creator, and to give a species of food for which the stomach is not then adapted.

It is true that, in the artificial state of society in which we live, the secretion of milk is sometimes delayed so long as to endanger the welfare of the child. In such cases, it may be necessary to give a few teaspoonfuls of fresh cow's milk diluted with water, as a temporary substitute for its natural food; but this ought to be only when the necessity is obvious, and in very small quantity at a time, otherwise the stomach and bowels will to a certainty suffer.

One evil result of the ignorance of the animal economy which prevails in society, is an habitual distrust of, or want of faith in, the efficiency of the laws which God has appointed for the regulation of the animal functions. We cannot rest satisfied with discovering and yielding obedience to his designs, but we also must do something to assist or *correct* them! At birth, for example, the stomach and bowels, never having been used for the purposes of digestion, contain a quantity of mucous secretion—*meconium*—which requires to be removed before they can enter upon their functions. To effect this object, nature has rendered the first portions of the

mother's milk purposely watery and laxative; and, on the part of the infant, nothing further is required than to allow it to follow its natural instinct and suck it in. Nurses, however, distrusting nature, often hasten to administer castor oil or some other active purgative in preference, and the result is the excitement of irritation in the stomach and bowels, which is not always easily subdued. If the young of the lower animals were treated after the same unnatural fashion, it can scarcely be doubted that the mortality among them also would be greatly increased.

That the prevalence of over-eating is a general error in society, especially among the sedentary classes, is strongly presumable, even without direct proof, from two almost characteristic circumstances —namely, the frequency of indigestion in one or other of its numerous forms, and the almost universal use of purgative medicines, with a view to remove from the system the superfluous materials which have been poured into it without any natural demand.

It is perfectly certain that, in the natural state of man, the bowels are quite able to act regularly without the aid of laxatives. If they are not, the Creator must have failed in accomplishing his aim—a conclusion which no rational mind can arrive at. If, on the other hand, they are intended and constituted to act without external aid, it necessarily follows that a wide departure from the order of nature must have taken place somewhere, to produce the inactivity which is now so generally complained of, especially among the middle and higher classes, and among females. On the principle we have laid down, of nourishment requiring to be proportioned to waste, it will not be difficult to explain in what this departure consists. It is in the mode of life being by far too sedentary to admit either of the natural waste, which alone renders nourishment necessary,

taking place, or of that constantly-recurring contraction and relaxation of the abdominal and respiratory muscles, which have been pointed out as aiding so effectually the peristaltic motions of the intestinal canal. If, in conformity with the diminished wants of the system, we reduce the quantity of food and increase the exercise, neither the oppression of repletion nor the need of opening medicine will be felt. But if, along with diminished exhalation and diminished muscular action, we persevere in eating copiously of nutritious aliments, either digestion must fail, the system become too full, or some artificial stimulus be given to aid the bowels in expelling its superfluous aliment.

Such, accordingly, are the results observable in every-day life. One is saved for a time from more serious evils by his stomach becoming enfeebled, and refusing to digest the excess of nourishment which it receives. In another, whose digestion is more vigorous, the system becomes full and excited to the brink of active or inflammatory disease, a sudden attack of which hurries him to the tomb. While a third gets rid of the load by stimulating the bowels to higher action than is natural to the mode of life: in other words, artificial waste is excited by purgatives, to supply the place of that which ought to result from the active use of the bodily powers, and which alone renders a full diet proper or safe.

It is not enough, then, to sit by the fire, blame nature, and lament over our unfortunate constitution, which obliges us to make such constant use of medicine. In the great majority of instances, nature is more willing to do her part than we are to do ours, and all that she requires of us is to fulfil those conditions without which she is powerless, and we are sufferers and unhappy. If we exercise our minds and bodies in healthful occupation, and seek to inhale the pure atmosphere which God has spread around us, so as to impart that gentle impulse to

the stomach and bowels which I have already described as necessary to their action, we shall have no need of laxatives to assist them. But if we choose to neglect his laws, and to live in bodily inaction within doors, and thus deprive the bowels of all natural aid, let us at least take the blame to ourselves, and not unjustly throw it upon the Ruler whose injunctions we thus practically despise. And if, while leading this inactive life, we continue to gratify taste by eating much more than waste requires, and thus stand in need of purgatives to enable us to throw off the load, let us at least be just, and, instead of lamenting over a defective constitution, let us deplore the ignorance which has hitherto blinded us to the perception of the truth, and led us to blame a Being whose arrangements are so evidently intended for our happiness.

During the active years of childhood and youth, when a strong instinct impels to much locomotion in the open air, how rarely do we find the stimulus of purgatives necessary to the proper action of the bowels, except after errors in diet or some unusual accident! And what is it that induces imperfect activity in later years, if not the change in the habits, occupations, and mode of life? If the lively and bounding girl, whose loose and unconstrained attire admits of the freest motion and fullest respiration, passes in a few months from the exuberant and playful indulgence of her feelings, intellect, and muscular system, to the quiet and composed inaction and confined dress of a sedate young lady, who never walks out except at a measured pace to school or to church, is it really wonderful that her stomach and bowels should begin to act with less vigour, and that, in time, her constitution should be so far impaired as to render necessary the constant use of laxatives? The stomach and bowels, in fact, are regarded very much as if they were independent powers residing within us, and placed there purpose-

ly for our molestation. So many heavy charges are continually brought against them, that they can scarcely ever be found in the right. They are blamed for every act of mischief which cannot be clearly proved against another organ; and yet, influential as they are in affecting our comfort, they are treated by us with very little care or ceremony. Their powers and wishes are consulted in nothing, but their backs are loaded at the caprice of their owners, worse, as Sir F. Head observes, than any pack-horse; nevertheless, we abuse them most emphatically when they sink to the earth overwhelmed by the weight imposed on them. They are, in short, the scape-goats which must bear all our physiological delinquencies, and save us the pain of blaming ourselves. If they feel uneasy after a heavy meal, it is not *we* who are to blame for having eaten it. No! it is the *fish* which lies heavy on the stomach, or the stomach which is unfortunately at war with soup, or potatoes, or some other well-relished article. *We* have nothing to do with the mischief except as meek and resigned sufferers. *We* never eat more than enough. *We* never devour lobsters, or oysters, or salmon, or cheese, or any thing which experience has told us our enfeebled stomachs cannot digest! We are too prudent and self-denying for that. And yet, somehow or another, our stomachs get hold of all these things in spite of us, and we must pay the same penalty as if we had eaten them deliberately, and with malice prepense! The case is hard, no doubt, that we cannot lead indolent and slothful lives, and yet enjoy the incompatible luxury of having the appetite of a rustic and the digestion of a tiger;—but since we are so unfortunately constituted that we must act like rational creatures or suffer the penalty, would it not be a wise proceeding to set a better watch on the stomach, and try to subject it to more effectual control?

In mature and middle age, after the effervescence and boisterous activity of youth are over, still greater caution than before becomes requisite. Growth no longer goes on, and nourishment is needed merely to supply waste; and accordingly the appetite becomes less keen, and the power of digestion less intense. If the individual continues from habit to eat as heartily as before, even after changing to a sedentary mode of life, the natural vigour of the digestive system may enable it to withstand the excess for a time, but ultimately dyspepsy, or some form of disease dependant on indigestion, will certainly ensue. The attempt to combine the appetite and digestive power of early youth with the altered circumstances and comparative inactivity of mature age, is the true source of the multitude of bilious complaints, sick-headaches, and other analogous ailments now so common and so fashionable in civilized society; and they will never be got rid of so long as their exciting causes are allowed to operate with unrestricted freedom.

The stomach, like every other organ of the body, is, for the wisest purposes, allowed a certain range, within which it may exercise its functions without injury to health; and it is only in virtue of such a power that it can adapt itself to the different circumstances in which an individual may be placed. If every trifling change in the quantity or quality of food were to be followed by mischievous consequences, no one could retain health for a single day; and if the stomach had no power of partially adapting itself to a particular kind of aliment, every change of place and of climate must soon have been attended by the loss of health and life; because there are scarcely any two places or countries in which precisely the same food would be set before us.

According to this law of adaptation, which, of course, has its limits, the stomach may be accus-

tomed to the reception of either a larger or a smaller quantity of food than what the necessities of the system require. If it is accustomed to too much, and less than usual be allowed, an unpleasant feeling of vacuity will arise, accompanied by a craving for more; but after a few days the unpleasant sensation will disappear, and the feeling of satisfaction be as great as if a full meal had been taken, and digestion will become more healthy and vigorous; whereas, if more food continues to be taken than what the system requires, merely to gratify the temporary craving, ultimate bad health will be the inevitable result.

This is precisely the error which is generally fallen into. The stomach is accustomed during youth to receive and digest a larger quantity of food than what is requisite to carry on growth and repair the ordinary waste of the system; and from custom, *not from want*, we continue to fill it as liberally after growth is completed and waste is diminished as we did before, when both were at their height. And if by any chance we eat less for a day or two, we mistake the temporary sense of emptiness for the indications of appetite, and are not satisfied till it is removed. The natural consequence is, that we educate the stomach to demand more food than the system requires, and more than it can itself continue to digest; and hence the numerous evils which we daily witness as fruits of indigestion.

In thus punishing us with the pangs of indigestion as a warning to more reasonable conduct, Providence displays the purest beneficence. To place this in a clear point of view, let us suppose digestion to continue perfect, notwithstanding the daily reception of an excess of food into the stomach, the result would necessarily be the regular formation of an undue quantity of chyle; this, in its turn, would produce an excess of blood throughout the

whole system ; and the individual would thus exist with all his functions in a state of constant oppression, and in continual danger of the rupture of a bloodvessel, till, from mere fulness, some active disease would be excited, requiring the instant and vigorous use of the lancet for its relief, or very probably cutting short life. If, then, man cannot restrain his appetites, and effectually subject them to the control of reason, another check against continued aberration is required; and, fortunately for us, it is to be found in the refusal of the stomach to continue to digest much more than the quantity demanded by the wants of the body. In practical life we meet, in fact, with both results. There are some persons constituted with such vigorous powers of digestion, that no quantity of food oppresses their stomachs. If they eat habitually more than what is required to supply waste and sustain the system, they speedily suffer from repletion, or some one or other of the diseases arising out of its existence, such as inflammation, apoplexy, rupture of bloodvessels, enlargement of the heart, or morbid growth in some organ of the body. In the greater number, however, of those who exceed in quantity, the stomach itself becomes enfeebled by the over-exertion to which it is subjected, just as the muscles do from excess of labour; and the consequence is impaired digestion, which prevents the food from being duly converted into chyle, and thus protects the system from the fulness which would otherwise be induced. Accordingly, it is a familiar truth, that those who eat most are not always the best nourished—and that, on the contrary, the stoutest men are often those who eat comparatively little.

It is therefore of great importance to be able to read aright the instructions of nature, and to act in conformity with their meaning. In practical benefit to ourselves it will make a great difference whether we regard indigestion as merely an acci-

dental and capricious occurrence, unconnected with conduct, or as purposely meant to warn us from continuing to act against laws instituted to secure our well-being and happiness. In the former case, we may go on unsuspectingly in the road to destruction till it is no longer in our power to turn back; whereas, in the latter, we cannot feel a single pang of indigestion without being reminded of some aberration from the path of duty, and seeking to return by the shortest way. It is too true that, even when aware that we are going wrong, we do not always choose to retrace our steps; but it is not less true that we shall be more likely to fulfil the laws of nature when we are made acquainted with their existence and intention, than when left to the guidance of ignorance alone. It must be observed, also, that hitherto mankind have not been taught the requisite knowledge till after their habits of action were formed; and therefore no inference can be drawn from their conduct in circumstances so unpropitious, which can with any fairness be held as applicable to the time when knowledge shall be communicated to the young as an indispensable part of a useful education.

If over-feeding be the prevailing error among the middle and higher classes of the community, the opposite condition is as unquestionably that of a large proportion of the labouring poor. Pressed upon all sides by the powerful competition both of constantly improving machinery and of a superabundant population, the manual labourer is impelled to undergo an amount of ever-recurring bodily exertion which far exceeds the natural powers of his constitution, even when supported by the fullest supply of nourishment; and when, as often happens along with this excess of labour, his food, from inadequate wages, the size of his family, or his own injudicious management, is defective in quantity or

in quality, the consequences to his health and happiness are disastrous in the highest degree.

To those who have never reflected on the subject, it may seem like exaggeration to say that, as a general fact, at least nine tenths of the lower orders suffer physically, morally, and intellectually, from being over-worked and under-fed; and yet I am convinced that the more the subject shall be investigated, the more deeply shall we become impressed with the truth and importance of the statement. It is true that very few persons die from actual want of food; but it is not less certain that thousands upon thousands are annually cut off, whose lives have been greatly shortened by excess of labour and deficiency of nourishment. It is a rare thing for a hard-working artisan to arrive at a good old age. They almost all become prematurely old, and die off long before the natural term of life. It is in this way that, as remarked by Dr. Southwood Smith, the mortality of a country may be considered as an accurate indication of the misery of its inhabitants. According to Villermé, the rate of mortality among the poor is sometimes double that among the rich. Thus it is found, he says, that in a poor district in France, one hundred die, while in a rich department only fifty are carried off; and that, on taking into account the whole population of France, a child born to parents in easy circumstances has the chance of living forty-two and a half years, while one born of poor parents can look for no more than thirty.*

These are striking facts, and their truth is confirmed by every day's experience in Britain as well as in France. Many causes concur to produce this melancholy result, but among the principal is unquestionably the disproportion so generally existing between toil and nutrition. In the army, the opera-

* Smith's Philosophy of Health, Chapter IV.

tion of the same principle has long been recognised in the inferior strength and health of the privates compared with the officers. The officers, being better fed, better clothed, and better lodged than the common soldiers, bear up successfully against fatigue and temporary privations by which the latter are overwhelmed. During epidemics, too, the poor, from their impaired stamina, almost invariably become victims in a proportion far exceeding that of the more wealthy classes. This is, no doubt, partly owing to their greater intemperance and want of cleanliness; but even these vices often derive their origin from the same root—the want of adequate repose and comfortable sustenance.

The bad consequences of defective nourishment are not confined in their operation to the bodily constitution of the labouring poor. *Their minds also are deteriorated.* The pressure of poverty is unfavourable to the growth of refinement and morality, and crime and turbulence are never so much to be dreaded as during times of scarcity and manufacturing or agricultural distress. Bodily health, satisfied appetite, and peace of mind, are great promoters of individual morality and public tranquillity; and whenever these are encroached upon in any great class of the community, discontent and crime are sure to follow. In legislation this principle is seldom attended to, and laws are consequently enacted merely for the suppression of the result, while the source from which it springs is left altogether unnoticed and in the fullest activity.

Among the poorer classes, the children as well as the parents suffer much both physically and morally from insufficient food. Their diet, being chiefly of a vegetable nature, and consisting of porridge, potatoes, and soups, with very little butcher-meat, proves far from adequate to carry on vigorous growth in the one, or repair waste in the other; hence arise in the young an imperfect develop-

ment of the bodily organization, a corresponding deficiency of mental power, and a diminished capability of resisting the causes of disease. In work-houses and other charitable institutions, ample evidence of these deficiencies obtrudes itself upon our notice, in the weak and stunted forms and very moderate capacities of the children. Under an empoverished diet, indeed, the moral and intellectual capacity is deteriorated as certainly as the bodily; and a full exposition of this fact, and the principles on which it is founded, would be a great public benefit.

Even among the children of the wealthier classes. a sufficiency of nourishing food is not always provided with the care which it deserves. Both in families and in boarding-schools, it is no uncommon practice to stint the healthy appetites of the young, or to feed them with soups and other eatables which contain too little nutriment in proportion to their bulk. I am acquainted with many instances of this most injudicious error, and have seen scrofula and severe digestive affections brought on by persevering in it through sheer ignorance, and even in the belief that such "temperance" was healthful. Where adequate exercise is permitted, and the food is plain and nourishing, hurtful excess in eating will rarely occur, at least in healthy children.

CHAPTER III.

OF THE KINDS OF FOOD.

What is the proper food of man?—Food to be adapted to constitution and circumstances.—Diet must vary with time of life.—Diet in infancy.—The mother's milk the best.—Substitutes for it.—Over-feeding a prevalent error.—Causes which vitiate the quality of the milk.—Regimen of nurses.—Weaning.—Diet after weaning.—Too early use of animal food hurtful.—Diet of children in the higher classes too exciting—and produces scrofula.—Mild food best for children.—Incessant eating very injurious.—Proper diet from childhood to puberty.—It ought to be full and nourishing, but not stimulating.—Often insufficient in boarding-schools.—Diet best adapted for different constitutions in mature age.—Regimen powerful in modifying the constitution, mental as well as physical.—Farther investigation required.

The next question which presents itself is, What is the proper food of man? In answering it, we must begin by making distinctions, otherwise we shall, in the very outset, fall into error.

On examining the structure of the human body at different ages and in different individuals, remarkable differences are observable in the relative proportions of the elements or tissues of which it is composed. In one, the muscular system predominates, and the body is remarkable for a compactness of fibre indicative at once of strength and activity. In another, the lymphatic system is the most conspicuously developed, and its features are easily recognised by the full, soft, and rounded form, and languid action, which generally accompany it. In a third, the thin and sharp outline, irregular and vivacious activity, and great susceptibility of impressions, betoken the predominance of the nervous

over all the other functions; while, in a fourth, the florid complexion, expanded chest, and general vivacity of disposition, as clearly point out the superior development and energy of the vascular system. Such are the four principal constitutions, long familiarly known under the names of the *bilious*, the *lymphatic*, the *nervous*, and the *sanguine* temperaments. Very frequently the habit of body indicates a mixture of two or more of these temperaments, in which case the results of course are modified according to the proportions in which they are combined.

The elementary textures being thus differently proportioned in different individuals, it follows that the aliment best suited for the support and repair of one is not always so for the others; in other words, a distinct modification of diet ought to be adopted for every marked variety of constitution, because *a direct relation ought always to subsist between the qualities of the food and the nature of the system which it is intended to nourish.* Thus, the highly concentrated and stimulating food which is found necessary for the proper sustenance of the trained pugilist or sportsman, whose muscular frame is in high development and constant exercise, would prove far too exciting to the slender and irritable constitution of a person whose characteristic feature is the predominant activity of the brain and nervous system. And, in like manner, the generous and stimulating diet which suffices merely to rouse a phlegmatic organization to ordinary energy, would prove by far too nutritive for a person of a florid and sanguine temperament, whose predisposition is already towards inordinate activity.

The necessity of adapting the diet and regimen to the individual constitution and mode of life, becomes so obvious to reason, when thus plainly stated, as to excite surprise that it should ever have been neglected. But, strange to say, although the ancient writers attached much importance to the

subject, the relation between diet and constitution, as a practical consideration, has of late been so entirely overlooked, and sound physiological principle has been so little consulted in the proper adaptation of the one to the other, that we are at this moment in possession of very little information of any value regarding it, and a long time must elapse before more can be supplied. My own observations have not been extensive or accurate enough to enable me to lay before the reader any new or definite results; and I notice the deficiency here only because I am deeply impressed with its importance, and hope that others may be induced to observe for themselves, and make known any information which they may obtain.

There is no kind of alimentary substance of which it can be said absolutely that it is always proper for the sustenance of man. To be serviceable, *the food must be adapted to the age, constitution, state of health, and mode of life of the individual, and to the climate and season of the year.* The same diet which, administered to an adult, is healthful and nutritious, may prove irritating and injurious to a child; and, in like manner, the stimulating animal diet which in winter is highly grateful to the system of a hard-working unexcitable labourer, may prove utterly destructive of health when indulged in during summer by an inactive and excitable female. It becomes, therefore, an object of deep interest to determine the principal causes and states of the system which render modifications of diet necessary.

Among these modifying causes, *the varying state of the body at different periods of life* ought certainly to be considered as one of the most influential. The differences observed in the constitution of the same person at different ages, are at least as great as those subsisting between different individuals at the same age. In infancy, the lymphatic and nutritive

functions greatly predominate over the muscular; and if the highly animalized food which suits the latter were then freely administered, it would infallibly induce disease, and fail to afford the requisite nourishment. In manhood, again, when muscular activity and nutrition are at their height, the lymphatic system in abeyance, and the person subjected to laborious exertion, the mild food of infancy would be equally misplaced. In advanced age, another change of constitution occurs. The soft tissues of early life have disappeared, and the whole frame is dry and wasted—a condition which, in its turn, requires food of a different kind from that fitted for either of the preceding stages.

Even the state of the digestive organs at different periods of life is sufficient to indicate a corresponding modification of diet to be proper for each. In early infancy, when no teeth exist, and the muscles which move the jaws are still comparatively small and powerless, and mastication is consequently impossible, milk from the mother's breast is manifestly the only food intended by nature for its use; and so long as it can be obtained of healthy quality and in sufficient quantity, no other ought to be substituted in its place. After the milk-teeth have made their appearance, but not till then, a little admixture may be permitted, and gradually and cautiously increased in proportion as dentition advances, and the stomach becomes fitted to digest other food. If, however, the appearance of the teeth be retarded by inability in the mother to furnish an adequate supply of sustenance (which sometimes happens), the deficiency must be made up either by providing a nurse of a healthy constitution, or by other means to be presently mentioned. The former is the preferable remedy; but where a nurse cannot be procured, and the mother's milk is scanty, the child may, after the third or fourth month, receive at proper intervals a small allow-

ance of cow's milk, diluted with one third of water, and slightly sweetened. This makes the nearest approach to the nature of the mother's milk, and is therefore more suitable than any preparation of milk and flour or arrow-root that can be given. Ass or goat milk answers still better.

The appearance of the first teeth is an indication that the digestive organs have become sufficiently developed to admit of small portions of barley-water, panado, a thin arrow-root, or milk and water, being given two or three times daily in addition to the nourishment drawn from the mother's breast, if the latter be at all deficient. Great care must be taken, however, neither to exceed in quantity, nor to give the food too rapidly; for otherwise the stomach will become too full, and be weakened by the efforts it is obliged to make. I have already pointed out the importance of attending to this rule; and, in accordance with it, nature, by arranging that the milk shall flow only by slow degrees, has taken care that, in suckling, the child shall receive its food very gradually. The very appearance of the teeth indicates a preparation of the digestive functions for more substantial aliment; and by beginning cautiously the use of small quantities of such simple articles as those above named, and gradually increasing them according to the wants of the system, an excellent preparation is made for the process of weaning, which would otherwise, by its suddenness, be attended with serious risk to both parent and child.

The milk *of the parent* ought, in every instance, to constitute the food of the infant, unless some very urgent reason prevents the mother from suckling, or renders her milk improper for the child. There is always a relation between the condition and constitution of the mother, and the age and constitution of the infant, which renders this proper, and which cannot exist between the child and any

other nurse, but which exercises an important influence on its nutrition. It is well known, for example, that during the first few weeks, the milk is thinner and more watery than it afterward becomes. If, consequently, a newly-born infant be provided with a nurse in the third or fourth month, the natural relation between its stomach and the quality of the milk is destroyed, and the infant suffers from the oppression of food being too heavy for its powers. If, again, an infant of five or six months old be transferred to a nurse recently delivered, the aliment which it receives is too watery for its support, and its health in consequence gives way.

In like manner, if the parent be of mature age, her own milk, or that of a healthy nurse of a nearly similar age, will be more suitable to the infant than the milk of a much younger woman; because the constitution of the offspring always bears a relation to that of the mother, and is adapted to the quality of the fluid which nature has provided for it. I speak, of course, only of the healthy state; for in cases of disease, the mother may be, and often is, the most unfit nurse that can be found for her own child. But as, in such instances, the parents are always guided in their conduct by medical advice, and this is not the place to discuss the treatment of disease, I need not now enlarge upon it.

The leading error in the rearing of the young, I must again repeat, is *over-feeding*—an error serious in itself, but which may easily be avoided by the parent yielding only to the indications of appetite, and administering food slowly and in small quantities at a time. By no other means can the colics and bowel-complaints, and irritability of the nervous system, so common in infancy, be effectually prevented, and strength and healthy nutrition be secured. Nature never meant the infant stomach to be converted into a receptacle for laxatives, carminatives, antacids, spicy stimulants, and astringents;

and wh n these become necessary, we may rest assured that there is something faulty in our management, however perfect it may seem to ourselves. The only exception is where the child is defectively constituted, and then, of course, it may fail to thrive under the best measures which can be devised for its relief.

Another cause of infantile indigestion, and which is too much overlooked through ignorance of its importance, is *vitiation of the quality of the milk*, caused by imprudence, neglect, or anxiety on the part of the mother. The extent to which this cause operates in inducing irritation and suffering in the child, is not generally understood; and accordingly, it is not unusual for mothers to display as much indifference to health, regimen, and tranquillity of mind during nursing, as if the milky secretion, and all other bodily functions, were independent of every external and corporeal influence. Healthy, nourishing, and digestible milk can proceed only from a healthy and well-constituted parent; and it is against nature to expect that, if the mother impairs her health and digestion by improper diet, neglect of exercise, impure air, or unruly passions, she can nevertheless provide a wholesome and uncontaminated fluid, as if she were exemplary in her observance of all the laws of health.

It is no new or uncertain doctrine that the quality of the mother's milk is affected by her own health and conduct, and that, in its turn, it directly affects the health of the nursling. Even medicines given to the parent act upon the child through the medium of the milk; and a sudden fit of anger, or other violent mental emotion, has not unfrequently been observed to change the quality of the fluid, so much as to produce purging and gripes in the child. Care and anxiety, in like manner, exert a most pernicious influence, and not only diminish the quantity, but vitiate the quality of the milk.

As soon, then, may we expect to see a bad tree bringing forth good fruit, as bad management good results; and low must that parent be ranked in the scale of moral beings, who, knowing the relation we have pointed out, can still deliberately sacrifice the welfare of her offspring by the improper indulgence of her appetites and passions, and by culpably neglecting the duties and restrictions demanded by her own health.

It is a common mistake to suppose that, because a woman is nursing, she ought therefore to live very fully, and to add an allowance of wine, porter, or other fermented liquor, to her usual diet. The only result of this plan is to cause an unnatural degree of fulness in the system, which places the nurse on the brink of disease, and which of itself frequently puts a stop to, instead of increasing, the secretion of the milk. The health and usefulness of country nurses are often utterly ruined by their transplantation into the families of rich and luxurious employers. Accustomed at home to constant bodily exertion, exposure to the air, and a moderate supply of the plainest food, they live in the enjoyment of the best health, and constitute excellent nurses. But the moment they are translated from their proper sphere, their habits and mode of life undergo an unfavourable change. Having no longer any laborious duties to perform, or any daily exposure to encounter, they become plethoric and indolent; and as they are at the same time too well fed, the digestive functions become impaired, the system speedily participates in the disorder, and the milk, which was at first bland, nourishing, and plentiful, now becomes heating and insufficient, and sometimes even stops altogether. The motive which induces the mother to take the nurse out of her proper element is extremely amiable—she is desirous to see that her infant is properly attended to; but the method which she takes to gratify this desire is not

on that account the less short-sighted and erroneous. If the nurse cannot be trusted with the child at her own home, care ought to be taken at least that her diet and mode of life be changed as little as possible from those which experience has proved to be most conducive to her health; and the system of feeding, confinement, and indolence usually resorted to, ought to be strictly prohibited, as fraught with evil to both nurse and child.

Nature, indeed, has saved mothers the necessity of oppressing their stomachs by way of providing for the wants of their young, and has enabled them to give suck without either suffering from exhaustion or having recourse to inordinate eating. This is accomplished simply by the suppression of that periodical evacuation to which all healthy women are subject during the greater portion of life, except when pregnant or nursing; and as, in every situation, it is certainly more advantageous for all parties to follow out the intentions of nature, than to substitute any contrivance of their own to effect a given end, so, in the present instance, more will be gained by the observance of the ordinary laws of health on the part of the nurse, than by any foolish deviation founded on ignorance and caprice.

The length of time during which an infant ought to be fed at the breast is subject to some variation. In this country, the end of the ninth month is usually considered a proper time for weaning; but much depends on the condition of the mother, and also on that of the child. If both are in vigorous health, if the infant has cut several of its teeth, and been already accustomed to be fed, and if the season be favourable, weaning ought to be then gradually accomplished. But if the nursling is feeble in constitution, the teeth late in appearing, and the nurse has a sufficient supply of good milk, especially if it be the winter season, it will be far better to prolong the nursing for a few months. In

such a case, the single fact of the non-appearance of the teeth would suffice to indicate an unfitness of the system for any other than the natural food from the maternal breast. In general, weaning takes place too early.

Where a healthy and well-constituted nurse has been provided, on account of the existence of an hereditary taint, such as active scrofula or cancer, in the parent, it is generally advantageous to defer the weaning beyond the usual time. But we must, in this case, be watchful not to delay it, if either the nurse or the child begins to suffer from its continuance.

It would carry me too far from the main object of this work to discuss all the contingencies against which it is occasionally necessary to provide in the management of the young. This, however, is scarcely required, seeing that medical advice is generally resorted to at the time of their occurrence; and the exposition of principles already given will enable most reflecting readers to decide for themselves how far they may safely trust to their own lights, without delaying to seek advice from others till the evil is done.

After the child has been weaned, panado, gruel, thin arrow-root, tapioca, sago, rusk, or crust of bread, may be allowed along with the fresh milk and water and sugar, which ought still to constitute the principal part of the food; and one or other ought to be preferred according to its effects. When these are given in moderate quantity, and not too frequently, they generally agree well; but in some delicate children they cause acidity, flatulence, and griping. In this case, a proportion of weak chicken-broth or beef-tea, freed from fat, and thickened with soft boiled rice or arrow-root, may be added.

The same kind of food ought to be continued till after the appearance of the canine or dog-teeth. When these have fairly protruded, a portion of soft-

boiled egg may be given as an introduction to the use of a more completely animal diet. In general, solid animal food ought not to be allowed in any quantity till all the teeth have appeared, and the digestive powers be fully adequate to its assimilation.

In this respect, there are two errors which ought equally to be avoided. If animal food be given too early, or in too great quantity, the system becomes excited, and diseases of irritation are apt to be produced, which impede nutrition, and lead ultimately to the production of scrofula and other organic changes in the glands and bowels, and not unfrequently also in the brain and lungs. In these instances, the child generally eats heartily, but nevertheless continues thin, and is subject to frequent flushing and irregularity of the bowels, headache, and restlessness. His mind partakes of the general irritability of the system, and peevish impatience takes the place of the placid good-humour natural to healthy childhood. In this state, the ordinary diseases of infancy—measles, scarlet fever, and hooping-cough—are often attended with an unusual and dangerous degree of constitutional disturbance; and when inflammation takes place, the necessary depletion is borne with difficulty, and the system does not easily rally.

The consequences now enumerated, and the error from which they spring, are most frequently met with in the middle and higher classes of society. Aware that animal substances contain the largest proportion of nutriment in a given bulk, but ignorant of the relation subsisting between particular kinds of food and particular states of the system, and which in practice can never be safely overlooked, the fond parent naturally imagines that the more nutritious the food, and the larger the quantity administered, the stronger and healthier will the child become. No suspicion is entertained that strong diet may overpower weak organs, and thus

induce the very evils which it is sought to avoid; whereas, by adapting the quality and quantity of the food to the condition of the system, the assimilating powers may be gradually invigorated, and healthy nutrition be completely ensured.

Among the wealthier classes, imperfect nutrition most generally arises from excess in quantity, or a too stimulating quality of food; but among the lower classes, from deficiency in quantity or quality, added to scantiness of clothing, want of cleanliness, and imperfect ventilation. And hence Dr. Clark, in treating of the prevention of scrofula and consumption in early life, lays great stress on the proper regulation of diet, and shows that, even in families free from all hereditary taint, a morbid condition of the system extremely favourable to the production of both diseases is speedily brought about by continued mismanagement of diet; and both the public and the profession are deeply indebted to him for drawing attention to the extensive influence of dyspeptic ailments in paving the way for the future inroads of a deadlier disease. It is true that it has long been the fashion to ascribe all bodily and mental disorders to bile, indigestion, or the state of the bowels; but the rationale of the result has seldom been perceived, or turned to any good account in improving preventive or remedial treatment. Dr. Clark's treatise, however, presents a remarkable exception, and may be referred to as a most instructive specimen of cautious and discriminating medical inquiry.

When we reflect that the object of digestion is to furnish materials for the growth of the body, and to supply the waste which the system is constantly undergoing, it must appear self-evident, that if the digestive powers be impaired by disease, by improper quantity or quality of food, or by any other cause, the result must necessarily be the formation of an imperfect chyle, and consequently of imper-

fect blood. The elements of the blood are derived from the chyle, and if *it* be vitiated, the blood also must suffer: if the blood be empoverished, so must necessarily be all the organs which it supplies; and if the body be thus debilitated, can any wonder be felt that it should no longer be able to resist the action of offending causes which full health alone can withstand? No matter whether the imperfect chyle springs from deficiency or excess, from too weak or too strong food, from constitutional debility or the inroad of disease—imperfect nutrition is its invariable consequence, and that cannot happen without exposing the system to morbid influences in a greater or less degree, according to the nature of the constitution and other concomitant circumstances.

Wisely, therefore, does Dr. Clark recommend early and earnest attention to a proper dietetic regimen, and insist that "the food of the child be regulated chiefly by the state of the digestive organs. In proportion to the delicacy of the child, the diet will in general require to be mild; when he thrives upon milk, farinaceous food, and light broths, no stronger or more substantial food need be used during the first two years of life: when he looks healthy and grows, and his bowels are regular (for this is one of the surest indications that the food is suited to the digestive organs), we have the best proofs that the diet agrees with him. When, on the other hand, the child appears heated or flushed towards evening, when he drinks greedily and more than is usual in children of the same age, and when his bowels do not act regularly, we may be assured that there is something wrong in the regimen employed.

"There is no greater error in the management of children than that of giving them animal diet too early in life. To feed an infant with animal food before it has teeth for masticating it, shows a total

disregard to the plain indications of nature in withholding such teeth till the system requires their assistance in masticating solid food. Before that period, milk, farinaceous food, and broth, afford that kind of sustenance which is best suited to the digestive organs, and to the nourishment of the system. The method of grating and pounding meat as a substitute for chewing, may be well suited to the toothless octogenarian whose stomach is capable of digesting it; but the stomach of the young child is not adapted to the digestion of such food, and will be disordered by it. When the child has the means of masticating, a little animal food may be allowed, but it should be of the lightest quality, and given on alternate days only; and even then its effects should be watched, for all changes in the regimen of children should be gradual.

"The frequent origin of scrofulous disease in defective nourishment has led to the opposite extreme, and children who are disposed to tuberculous disease are too often subjected to a system of over-feeding, which induces the disease it is intended to prevent. By persevering in the use of an over-stimulating diet, the digestive organs become irritated, and the various secretions immediately connected with digestion are diminished, especially the biliary secretion; at least the sensible qualities of the bile enable us to observe it best. Constipation of the bowels soon follows; congestion of the hepatic and abdominal veins succeeds, and is followed by the train of consequences which have already been detailed. It would be well if the advocates of the system of high feeding would bear in mind the salutary adage, *corpora impura quo plus nutries, eo magis lædis.*"*

In proportion as the organization becomes developed, and strength, activity, and aptitude for abun-

* Clark on Consumption and Scrofula, p. 283.

dant exercise increase, a larger allowance of plain animal food becomes essential to health. The instruments of mastication are now fully adequate to their office, and the stomach is no longer oppressed by the effort of digesting it. To make it safe, however, even at that age, ample exercise and exposure to the open air are indispensable. By undue confinement to the house or to school, and deficient exposure to the air, a degree of general delicacy is kept up which is incompatible with the daily use of a stimulant animal diet. The waste occasioned by the bodily action is too limited to require the copious supply of any very nutritious substances, and if these be freely allowed, they serve only to oppress the digestive functions and impair the health.

The prevalent and pernicious custom of tasking the minds and confining the bodies of children for hours in succession at home and in schools, at a time of life when the growth of the body and the welfare of the system require constant and playful exercise in the open air, and perfect freedom from care and excitement of mind, is the fruitful source of much future bad health, and is eminently calculated to defeat the object aimed at by parents, namely, the mental excellence of the child. The premature exertion of intellect to which it is stimulated by the constant excitement of emulation and vanity, far from strengthening, tends to impair the health and tone of the brain, and of all the organs depending on it; and hence we rarely perceive the genius of the school manifesting in future years any of the superiority which attracted attention in early life; but we find him, on the contrary, either sunk below mediocrity, or dragging out a painful existence, the victim of indigestion and melancholy. On the other hand, some of the most distinguished men who ever lived were in childhood remarkable only for health, idleness, and apparent stupidity. The illustrious Newton was, by his own account, an idle

and inattentive boy, and "very low in the school," till he reached twelve years of age; and the young Napoleon himself is described as "having good health, and being in other respects like other boys." Adam Clarke was considered "a grievous dunce" when a boy, and was seldom praised by his father except for his ability *in rolling large stones*, which his robust frame and good health enabled him to do. Shakspeare, Gibbon, Byron, Scott, and Davy, were in like manner undistinguished for precocious genius, and were fortunately allowed to indulge freely in those wholesome bodily exercises, and that freedom of mind, which contributed so much to their future excellence. The mother of Sheridan, too, long regarded him as "the dullest and most hopeless of her sons."

Among the many who give great promise in early life, and whose talents are then forced by ill-judged cultivation into precocious maturity, how few live to manhood to reap the reward of their exertions, and how few of those who survive preserve their superiority unimpaired! Tasso was early distinguished, and wrote his immortal epic at twenty-two years of age; but his life was miserable, and his reason disordered, and he died at thirty-two. Pascal is another example of the same result, and Kirke White and many others might be named were it necessary.*

Experience, indeed, amply demonstrates, that precocious and excessive activity of intellect and vivacity of feeling are most powerful impediments to healthy and vigorous digestion, and consequently to a sufficient nutrition. In early life, therefore, when not only health, but future usefulness, depends main-

* On this and kindred subjects, the reader will find much valuable information in Dr. Brigham's Remarks on the Influence of Mental Cultivation and Mental Excitement upon Health; reprinted, with Notes, by Dr. Robert Macnish. Glasgow, 1836.

ly on the completeness and vigour with which the system shall proceed towards its full development, the preservation of the digestive organs by suitable diet, exercise, and regimen, ought to be a primary object of attention with every sensible parent. Even as regards superiority of mind, the healthy development of the body is of essential importance, as the only sure foundation on which mental excellence can be built ; because, so long as mind and body are intimately connected with each other, the former must continue to be affected by every change in the condition of the organization on which it depends. We enjoy acuteness of vision by preserving the eye in high health, and exercising it regularly and moderately ; and, in like manner, we can obtain and preserve intellectual power only by preserving the health of the brain, and exercising it in conformity with its natural constitution.

Instead, then, of feeding the closely-confined and excitable children of the middle and higher classes from early infancy on quantities of stimulating animal food, and even giving them wine and fermented liquors, we shall act more in accordance with the laws of nature by restricting them, during the three or four earliest years of childhood, chiefly to a mild farinaceous diet, with a small allowance of meat on alternate days ; and by seeking to increase their digestive power and bodily vigour by constant exercise in the open air, before giving them a more solid diet. By these means the development of the organization, the keenness of appetite, the tone of digestion, and the desire of, and fitness of the system for, animal food, will increase in regular proportion, and a free supply of that species of aliment will even become necessary to carry on the growth. In short, it must ever be remembered, that strength is to be obtained not from the kind of food which contains most nourishment in itself, but from that

which is best adapted to the condition of the digestive organs at the time when it is taken.

Children who are prone to bodily exertion, and live almost entirely in the open air, as many of those of the lower orders do, and who display no unusual sensibility or activity of mind, or, in other words, no unusual irritability of the nervous system, not only bear, but require a larger proportion of animal food than their more delicate and sensitive companions. Not only is their digestion more vigorous, but the waste going on in the system is much greater, and the nutritive functions are more active; the need, consequently, for nourishing food, and the desire to procure it, are proportionally increased. Hence it happens that, in the wealthier classes of society, young children suffer most from over-feeding, while in the poorer classes they suffer chiefly from the opposite cause. In both, defective nutrition is the result; but the modes in which it is brought about are very different.

One of the most pernicious habits in which children can be indulged is that of almost incessant eating. Many mothers encourage it from the facility with which, for a time, the offer of "something nice" procures peace. Even from infancy, the child ought to be gradually accustomed to eat only when hungry, and when food is really required. After two years of age, an interval of four hours between meals will rarely be more than enough; and to give biscuit, fruit, or bread in the meantime, is just subtracting from the digestive power of the stomach. Like almost every organ of the body, the stomach requires a period of repose after the labour of digestion, and accordingly, in the healthy state, the sensation of appetite never returns till it has been for some time empty. To give food sooner, therefore, is analogous to making a weary traveller walk on without the refreshment of a halt.

It is a great mistake to suppose that children

would not be quiet or contented without such indulgence. On the contrary, they would be healthier and happier were the *opposite* system steadily pursued. The greatest obstacle to be encountered is the ignorance of the nurse or mother, and her want of resources for the entertainment and exercise of the child's bodily and mental faculties. If these be duly attended to, the child will not think of eating till the return of appetite enforces the demand; whereas, if it be left idle and neglected, every thing will be carried to its mouth, as its only remaining resource against absolute inanity. So true is this, that I should regard that nurse as unfit for her employment who should complain that her charge, otherwise in good health, is incessantly craving for something to eat. In this respect children are like adults. Give them something to do and to think about, and they will seek meat only when hungry. But leave them idle and listless, and eating will become their chief subject of contemplation.

In a matter so important as the rearing of children, one would imagine that every mother and nurse would be anxious for instruction on the nature, functions, and wants of the being committed to their fostering care. And yet it is notorious how rarely either one or other of them possesses any but the crudest notions of the animal economy, or can give reasons for the practices they recommend, or modify them in any degree to suit modifications of circumstances and constitution. In reality the wonder comes to be, not that so many children die, but that so many survive their early mismanagement.

From the age of six or seven years up to that of puberty, when the animal activity is at its height, growth in full progress, and the nutritive functions in their greatest vigour, a larger proportion of animal food, and a more generous diet, become neces-

sary to the enjoyment of health and vigour; but they must still be accompanied by ample exercise and free exposure, otherwise they will tend only to clog and impede the functions of life. At that age the teeth and other organs concerned in digestion have become developed and fit for the assimilation of a richer aliment, and the rapid growth which takes place renders an abundant provision of the latter in a manner indispensable. It is then that the healthy youthful appetite demands quantity as well as quality, and that digestion goes on with an ease and vigour which the dyspeptic parent contemplates with a covetous and regretful eye.

At that age, indeed, the nutritive functions are so predominantly active for the purpose of carrying on growth, and supplying the rapid waste caused by youthful activity, that if the natural craving for exercise in the open air be freely indulged, and due attention be given to the development of the bodily frame, the young may be very safely left to choose for themselves both the quality and quantity of their food. In such circumstances, the natural taste inclines so essentially to the preference of plain substantial nourishment, that there is very little risk of excess being committed. But where the parents are intent only on the intellectual advancement of their children, and accustomed to subject them daily to many successive hours of confinement and study, with only an hour or so of relaxation in the open air, as is too commonly the case both with those educated at home and with those in boarding-schools, an artificial state of being is induced, which makes the rule no longer applicable, and renders necessary a more careful attention to dietetic regimen.

Among the higher classes of society the unrestricted use of the most exciting kinds and preparations of animal food, and the daily use of wine, are the means generally resorted to for the removal

of the delicacy thus engendered; but when we consider the real state of the case, no remedy can seem more preposterous. The evil to be corrected is imperfect nutrition and the want of strength. The imperfect nutrition, however, is caused, not by deficient food, but by impaired powers of digestion and assimilation, and these suffer only because the lungs are denied the free air, the muscles their necessary exertion, the brain its cheerful recreation, and the circulation the healthy stimulus which these united conditions infallibly produce. Instead, therefore, of oppressing a weakened stomach by administering stronger food than it has the power of digesting, the natural way of proceeding would be to prescribe at first a milder and less stimulating diet, —to improve the tone of digestion by fulfilling the conditions above referred to,—and then, in proportion as the stomach was strengthened, to adopt a more nourishing diet, suited to the increased efficiency of all the animal functions.

By running counter to this method, and using highly stimulating food improperly, many young people of the wealthier classes incur as much suffering from imperfect nutrition, and the diseases to which it predisposes, as if they were really the victims of an empoverished diet. Dr. Clark, after making some very judicious remarks on the influence of bad digestion in inducing the consumptive constitution of body, expresses himself strongly on the evils to which I have just alluded. "Food in excess," he says, "or of a kind too exciting for the digestive organs, may also induce tubercular cachexia,—a circumstance which is not sufficiently attended to,—I may say, not generally understood, even by medical men; nevertheless, I hold it to be a frequent cause of scrofula, and believe that it produces the same effect on the system as a deficient supply."—"The imperfect digestion and assimilation in the one case, and the inadequate nourishment in the other, being

equally injurious; the form and general characters which the disease assumes may differ, but the ultimate result will be the same in both cases. The adaptation of the food, both in quality and quantity, to the age of the individual, as well as to the powers of the digestive organs, is too little considered; and the evil consequences of this neglect are often evident in the children of the wealthy classes of society, who are allowed an unrestricted use of the most exciting kinds of animal food."*

The opposite error, of not providing a sufficiently nourishing diet for the young, is, from mistaken views, much more prevalent than it ought to be, particularly in female boarding-schools, where, as already mentioned, the system of diet is often insufficient for due sustenance and growth; and where, consequently, the natural expression of impaired health, if not actual disease, is a marked feature in the aspect of most of the pupils. So defective, indeed, is the common school management in this and other respects, that we have the best authority for considering it as a rare exception for a girl to return home in full health after spending two or three years at an ordinary English boarding-school.†

It is true, that much of this result is owing to excessive confinement, neglect of cheerful exercise, ill-ventilated sleeping apartments, and other depressing influences; but to these, that of an insufficient diet may often be added; and when it does exist, it acts with double force from the impaired digestion, which seldom fails to ensue where the laws of health are so widely outraged.

I have seen some striking instances of incurable scrofulous disease induced by the depressing influence of misfortune, added to the want of a sufficient supply of nutritious food. After the mercantile dis-

* Clark on Pulmonary Consumption and Scrofula, p. 230.

† Dr. Forbes in Cyclop. Pract. Med., vol. i., p. 698, foot-note.

asters of 1825-6, many cases of this kind occurred, especially in families whose sensitive feelings induced them to shrink from public observation, and to suffer the severest privations rather than allow their situation to become known. In these cases, the tone of the general health first became reduced, and then local disease was easily excited by any trivial cause. In one, the structure of the bones and joints became disorganized, and amputation of the limb preserved life, but could not prevent other parts of the osseous system from being attacked. In another, caries of the bones of the foot ensued, but the constitution itself was so thoroughly tainted that no operation could be performed with even momentary success, and, after much suffering, the patient died. The same causes undermined the health of another member of the same family, and led to his death, from consumption, at an early age.

In regard to the diet best adapted to different constitutions in mature age, I have already confessed that I have little information to offer. In determining the question, several other circumstances besides the mere temperament require to be considered. A more or less laborious mode of life, for example, will require a more or less nutritious diet, whatever the original habit of body may be. In like manner, if any temperament be in excess, and we wish to repress its predominance, the same kind of food which is suitable for it in a lower degree will no longer be applicable. Thus, when the lymphatic constitution is predominant, and our object is to diminish its ascendency, and stimulate the system to greater vigour, a larger proportion of solid nourishing food, combined with increased exercise, will be more proper than if there is no such excess. Where, on the other hand, the nervous or sanguine temperament preponderates, a plainer and less ex-

citing regimen will be necessary than where the constitutional tendencies are more equally balanced.

The power we possess of modifying the constitution by well-directed regimen is very great, and only requires to be investigated and made known to have due importance assigned to it in conducting physical education. This is well exemplified in the art of training, where diet and exercise are reduced to a practical science for the attainment of certain results, and with remarkable success. In the hands of a trainer, the breathless and oppressed frame of a person overburdened with lymph and fat, speedily becomes converted into an active, firm, and well-conditioned organization, exhibiting a promptitude of action of both mind and body the very opposite of its former manifestations; and if such a change can be effected by rigid adherence to rules, in the course of two or three months, we may easily conceive the degree of improvement which would follow the uniform observance of proper regimen and dietetic precepts in ordinary society. In improving the moral and intellectual, as well as physical condition of the working classes, the influence of food, air, and exercise will soon be discovered to possess a degree of importance of which at present scarcely a suspicion is entertained. They constitute, in fact, the very foundation of a systematic education; and mere intellectual cultivation will fail to produce its full beneficial results, till the organization by which the mind operates be itself improved by a treatment in harmony with its own constitution.

If it be impossible for me to communicate sufficient information to enable each of my readers at once to determine the kind of diet which is likely to suit him best, it will give him at least some satisfaction to know, that, by observing personally what kind of food agrees best with his stomach and constitution, he may soon obtain the necessary information for himself. When we refrain from eating too

much, and at unseasonable hours, and are not conscious of any undue oppression or discomfort after our meals, but, on the contrary, feel light and refreshed, and, after a time, ready for renewed exertion, we may rest assured that the food which we have taken is wholesome and suitable for us, whatever be its nature and general effects. Whereas, if, without committing any excess or other dietetic error, we experience the opposite sensations of oppression, languor, and uneasiness, we may be just as certain that our food, whatever its general character for lightness and digestibility, is not wholesome or suitable for us under our present circumstances. So that, with a little care and trouble, we shall rarely be at any loss to find out what we ought to eat and what to avoid; and, accordingly, it is notorious that indigestion from a wrong choice of food is induced at least nine times by wilful indulgence, for once that it occurs from errors originating in ignorance alone. If the proper *quantity* of food be not exceeded, and the other conditions of digestion be carefully fulfilled, the risk of mischief from an erroneous choice of aliment will be greatly diminished

After the full exposition of the laws of digestion given in the first part of this work, I need hardly add, that although there are very few articles of diet which a person in health, and leading a sufficiently active life, may not eat with impunity, there are nevertheless some which ought to be preferred, and others which ought to be avoided, by those *whose digestion is impaired.* Thus, vegetables are, generally speaking, slower of digestion than animal and farinaceous aliments, and consequently, when digestion is feeble, are liable to remain in the stomach till acetous fermentation takes place, and give rise to acidity and flatulence. Fat and oily meats are nearly in the same predicament, and hence

both form unsuitable articles of diet for dyspeptics. Soups and liquid food are also objectionable, both because they are ill adapted for being properly acted upon by the gastric juice and by the muscular fibres of the stomach, and because they afford insufficient nourishment. From the former cause they frequently impair the digestive functions; and from the latter, they induce diseases of debility which it is difficult to subdue. Daily experience furnishes examples of stomachic disorder from eating soups, especially as preliminary to an otherwise substantial dinner; and the fatal epidemic which prevailed a few years ago in the Milbank Penitentiary, was distinctly ascertained to have been partly caused by an insufficient and too liquid diet. It is common, indeed, to see heartburn and indigestion of recent origin cured simply by giving up soups and vegetables, and diminishing the quantity of liquid taken at breakfast and tea.

When, from the state of health or other causes, chicken-tea, beef-tea, veal-broth, or other kinds of soup require to be given, their digestibility will generally be promoted by the addition of bread or rice to give them consistency, and by taking little or no other food along with them. Even vegetables, when taken alone, are sometimes digested without difficulty, where, if mixed with other substances, they disorder the stomach. Dr. Abercrombie mentions a very remarkable instance of this kind in a gentleman who "had been for many years a martyr to stomach complaints, seldom a day passing in which he did not suffer greatly from pain in his stomach, with flatulence, acidity, and the usual train of dyspeptic symptoms; and, in particular, he could not taste a bit of vegetable without suffering from it severely. He had gone on in this manner for years, when he was seized with complaints in his head, threatening apoplexy, which, after being relieved by the usual means, showed such a constant ten-

dency to recur that it has been necessary ever since to restrict him to a diet almost entirely of vegetables, and in very moderate quantity. Under this regimen, so different from his former mode of living, he has continued free from any recurrence of the complaints in his head, and has never been known to complain of his stomach."* In this case, however, the *very moderate quantity* of vegetable food to which the patient restricted himself had perhaps no small share in the subsequent improvement of his digestion.

Dr. Beaumont mentions, as a general result from his experiments on St. Martin, that vegetable food is slow of digestion; but it is much to be regretted that he gives the particulars of only one or two trials, which lead to no very important results. In one of these, St. Martin ate "nine ounces of *raw, ripe, sour* apples, at 2 o'clock 35 minutes. At 3 o'clock 30 minutes the stomach was full of fluid and pulp of apples, quite acrid, and *irritating the edges of the aperture, as is always the case when he eats acescent fruits or vegetables*."† In another instance ten ounces of *raw cabbage* were given, and in two hours not a particle of it was to be found in the stomach; while on a third occasion, half a pound of *raw cabbage*, cut fine, and macerated in vinegar, disappeared in little more than one hour and a half! If in the latter experiments the cabbage was really digested, and not merely propelled out of the stomach into the intestine, we shall be forced to admit that we have still much to learn concerning the digestibility of different kinds of food, for the result is contrary to all generally received opinions. When vegetables are allowed, great stress is commonly laid upon the necessity of their being thoroughly cooked; and yet, accord-

* Abercrombie on Diseases of the Stomach, &c., 1st edit., p. 73.

† Beaumont's Experiments and Observations, &c., p. 243.

ing to these experiments, *raw* cabbage is very nearly as digestible as soft boiled rice or sago! It is strange that Dr. Beaumont should not have remarked this anomaly, which he seems not to have done, since he neither attempts to explain it nor alludes to it as any thing extraordinary. My own suspicion is, that the cabbage was not entirely digested, but had merely passed through the pylorus into the intestine.

Dr. Beaumont's testimony in favour of farinaceous vegetables is, however, more precise and satisfactory. In some of his experiments, St. Martin digested completely a full meal of *boiled rice*, seasoned with salt, in a single hour. *Soft custard* and *boiled rich sago*, sweetened with sugar, and taken in quantities of a pint each time, were disposed of with nearly equal despatch, "and there was no acrimony of the gastric contents, or smarting of the edges of the aperture during their chymification, as is usual in most vegetable and farinaceous aliments;" on the contrary, the sago "seemed peculiarly grateful to the surface of the stomach, rendering the membrane soft, uniform, and healthy."* In these instances, it ought to be remarked, nothing else was eaten at the same time; so that the stomach was not oppressed by *quantity*.

In early life, when digestion is vigorous, the system excitable, and the habits peculiarly active, a full proportion of vegetable and farinaceous food is proper and salutary. Morning and evening meals of this description, prepared with milk, or taken along with it, are very useful—animal food being reserved for dinner alone. But as age advances and excitability diminishes, and perhaps, also, as habits of activity and exposure to the open air are changed, the same proportion of vegetable and farinaceous food can no longer be digested so easily, and therefore ought not to be continued.

* Beaumont's Experiments and Observations, &c., p 249

Pastry, rich cakes, puddings, and other articles containing much fatty or oily matter in their composition, are perhaps the most generally indigestible of all kinds of food, and consequently ought never to be eaten when the tone of the stomach is impaired. There are states, however, in which oily articles seem to agree better than lean. I have seen very fat fried bacon, for example, digested with ease at breakfast, where even a small potato would have disordered the stomach. It is very difficult to afford any explanation of the fact, which, however, is not uncommon. Perhaps it is dependant on a peculiar state of the biliary secretion, for Dr. Beaumont often remarked that the presence of bile in the stomach facilitates the digestion of fat and oily aliments, and that, even out of the stomach, gastric juice dissolves suet faster when a little bile is added to the mixture than when the juice is pure. He mentions, moreover, that he never found bile in the stomach, at least during health, except when food of an oily kind had been eaten; and, in accordance with this, I have generally noticed that fried bacon agrees best with what are called "bilious" subjects. Still, however, the quantity must be small, otherwise it will prove injurious.

Plain, well-cooked animal food, not too recently killed, and eaten in moderate quantity, with bread, rice, or roasted potatoes, forms one of the most easily digested meals which can be devised for a weak stomach. Sometimes, however, potato induces acidity and flatulence, and ought not to be used. Venison and most kinds of game are very suitable in the same circumstances.

In some conditions of the system, where the condition is irritable, and the mode of life not sufficiently active, red, highly animalized meat proves too stimulating, although easy of digestion. The same happens during recovery from illness; and hence fish, chicken, and other white meats, which excite

less and are digested more slowly, are often allowable where beef, mutton, pork, &c. cannot be taken with impunity. For the same reason, white and young meats are the best adapted for the excitable systems of the young.

It would be easy to fill many pages with disquisitions about the preference due to individual articles of food, were such the purpose which I had in view. But books devoted to this branch of the subject abound, and are already in general circulation; and as I have nothing new to add to what is contained in them, it would be making a needless demand on the patience of the reader merely to repeat what is to be found in so many other works. My object is the exposition of PRACTICAL PRINCIPLES rather than of minute details; and my great aim is to enable every intelligent person to understand, not only what digestion is, but the laws by which it is regulated, so that he may know at once WHY it is for his advantage to adhere to one course of conduct in preference to another in regard to it—WHY, in different situations, diet requires to be modified in order to adapt it more effectually to the varying wants of the system—and, lastly, the circumstances or rules by which such modifications ought to be determined. If I have succeeded in the attempt to explain any or all of these principles sufficiently to render them susceptible of a practical application by the reader, not only I shall be greatly pleased, but the advantage to him will speedily convince him that I have acted judiciously in forsaking the beaten path, and drawing his attention to truths of still greater importance to his welfare than those which are most commonly treated of under the title of dietetics.

CHAPTER IV.

CONDITIONS TO BE OBSERVED BEFORE AND AFTER EATING.

General laws of organic activity apply to the stomach as well as to other parts.—Increased flow of blood towards the stomach during digestion.—Hence less circulating in other organs.—And consequently less aptitude for exertion in them.—Bodily rest and mental tranquillity essential to sound digestion.—Rest always attended to before feeding horses.—Hence also a natural aversion to exertion immediately after eating.—Mischief done by hurrying away to business after meals.—Severe thinking hurtful at that time.—Playful cheerfulness after dinner conducive to digestion.—The mind often the cause of indigestion.—Its mode of operation explained.—Also influences nutrition.—Illustration from Shakspeare.—Importance of attending to this condition of health enforced.

Having now discussed the principles by which the number, quantity, and quality of our meals ought to be regulated, we have next to consider the conditions required for the healthy performance of digestion after the aliment has reached the stomach, and to deduce from them such practical rules as shall tend to facilitate the accomplishment of the process.

Among the circumstances which favour digestion, the observance of bodily rest and mental tranquillity for some time before and after every meal is perhaps the most important; its influence depends on a well-known law of the animal economy, already frequently alluded to, but to which, that it may be fully understood, I must again shortly refer.

Whenever any living part is called into vivid action, an increased flow of blood and of nervous energy towards it immediately commences, to ena-

ble it to sustain the requisite degree of excitement, and continues till some time after the activity has ceased. In accordance with this law, whenever food is swallowed, the lining membrane of the stomach becomes suffused with blood, and, owing to the greater distension of its vessels, its colour changes from a pale pink to a deep red hue. After digestion is completed, and the unusual supply of blood is no longer required, the vessels again diminish, and the colour returns to its original tint. In St. Martin's stomach, these changes were so often seen by Dr. Beaumont, as to render their occurrence as fully demonstrated as any circumstance with which we are acquainted. Even had they never been seen, the simple examination of the structure of the stomach would lead us directly to the inference that it receives an additional supply of blood when engaged in digestion; for the very act of its distention by food renders the course of its blood vessels less tortuous, and the flow of blood through them consequently more easy and rapid. In the case of the stomach, indeed, the increased circulation is doubly required; not only, as in other parts, to enable it to act with greater vigour, but also to supply the very copious secretion of gastric and mucous fluids necessary for digestion, and which we have seen to commence the moment food touches the mucous coat. The quantity of gastric juice actually secreted at each meal cannot easily be determined; but as more than an equal weight of it is required for the solution of food out of the stomach, its amount must be very considerable. Indeed, we know that, on one occasion, when St. Martin dined on broiled mutton and bread without any liquids, the gastric secretion was so copious, that half an hour afterward the "stomach was as full of fluids as when he drank a pint immediately after eating;"* and, as the

* Beaumont's Experiments and Observations, &c., p. 185.

whole of this must have been derived directly from the blood circulating through the vessels of the stomach, they must necessarily have received a very large supply to enable them to furnish it.

It is obvious, however, that the grand afflux of blood which takes place towards the stomach and intestines during digestion, cannot occur without a corresponding diminution in the quantity circulating on the surface and in other distant parts of the body, attended, of course, with a diminished power of action in them. Hence, for some time after a full meal, there is an inaptitude for vigorous thinking and bodily exertion, a depression of respiration, and, in delicate persons, a degree of coldness or chill felt over the whole body. But, under ordinary circumstances, this depression is not of long continuance. After the requisite secretions have been provided for the solution of the food and the formation of the chyle, a reaction and change in the distribution of the blood, now partially renewed by the admixture of nutritive chyle, ensue, and, by the stimulus which they afford, soon fit the person for the active resumption of his ordinary duties.

That this impaired activity of the other functions after a full meal is natural, and intentionally arranged by the Creator, is plain, both from its universality among all kinds of animals, and from the mode in which it is produced. Among the lower creatures, the sluggishness induced by eating increases in proportion to the degree in which they gorge themselves with food. The boa constrictor, after a plentiful repast, slumbers for a week; and the glutton of our own species, in similar circumstances, drops into a stertorous sleep of several hours. If active exertion immediately after a full meal be rendered compulsory by any external cause, such as the presence of danger urging to flight, the aliment often remains for hours in the stomach undigested. Again,

the very distention of the stomach inseparable from a hearty meal, *necessarily* impairs the activity of several of the functions, by directly pressing upon the vessels which supply their organs with blood, and consequently diminishing the stimulus essential to their activity.

The obvious practical inference to be deduced from a consideration of the principle under discussion is, that rest of body and tranquillity of mind for a short time both before and after eating are necessary, and conducive to healthy digestion. If we have been engaged in severe and fatiguing bodily exertion, or anxious meditation, just before sitting down to a meal, the blood which was flowing copiously through the vessels of the muscles or the brain to keep up their unusual action, still continues to do so, because a sufficient interval has not elapsed to allow the excitement to subside, and a new distribution to take place towards the organs concerned in digestion. The consequence is, that the stomach does not receive blood enough to carry on its increased action, and furnish gastric juice with sufficient rapidity, or in sufficient quantity, to mix with the whole of the food; and that the nervous energy, already partially exhausted by over-excitement in the remoter organs, is imperfectly supplied to the stomach, the tone and action of which are thus so far impaired as to render it no longer able to carry on digestion with its usual success. Accordingly, when we are fatigued with mental or bodily labour, we are naturally impelled to seek repose before sitting down to table; and if we yield to this instinctive prompting, and refresh ourselves by a rest, we not only enjoy better what we eat, but also digest it with an ease and comfort unattainable by swallowing our food the moment our labour is at an end; and hence the wisdom and advantage of appropriating half an hour to any light occupation, such as dress-

ing, before sitting down to dinner. If, however, we have previously been engaged only in very moderate exercise, an interval of repose is not required, because then there is no undue excitement elsewhere to retard the necessary flow of blood and nervous energy towards the internal organs.

The practical rule of avoiding serious exertion of mind or body immediately after eating, which is directly deducible from the physiological law above explained, has long been acted upon in our treatment of the lower animals; and no one who sets any value on the lives of his horses or dogs, ever allows it to be disregarded with respect to them. And yet the same man who would unhesitatingly dismiss his groom for feeding his horse immediately after a fatiguing chase or a gallop home, would probably think nothing of walking into the house and ordering dinner to be instantly served for himself in similar circumstances. In the army, the difficulty of managing recruits, on a march, in this respect, has often been remarked. Fatigued with the day's exertions, they are impatient for food, and, when they get it, can scarcely refrain so long from devouring it as to admit of its being even moderately cooked. They consequently labour under the double disadvantage of eating before the system is in a sufficient state of repose to benefit by the supply, and of having the food itself in a condition unfit for easy digestion. The old campaigner, on the other hand, instructed by former experience, restrains his appetite, systematically kindles his fire, cooks his victuals, and makes his arrangements for the night, with a coolness of deliberation which surprises the recruit; and he is amply repaid for his temporary self-denial, by the greater enjoyment and support which he derives from the very same materials which the impatience of the other has caused him in a great measure to waste.

Let any one who doubts the advantages resulting

from attention to this rule, consider for a moment its universal and scrupulous observance by post-masters and jockeys, and think whether these are persons likely to throw away time and trouble on a useless ceremony. When a horse is taken out of harness, an interval of repose is always allowed, that the excitement of the system may have time to subside; and then not only an eager appetite but an active digestion are sure to follow. Many a valuable horse has been killed by being prematurely fed after fatiguing exercise, and man himself is no exception to the rule. He not only enjoys a meal with superior relish, but digests it better, when due repose has removed the fatigue and excitement of exertion. Even after continued activity of *mind*, a period of tranquillity or of gentle bodily exercise is eminently conducive to the healthy action of the stomach, precisely because it favours the new distribution of the circulating blood which that process requires.

In accordance with this law of digestion, there is throughout the whole animal creation a marked aversion to activity for some time after a full meal, although man, eager in the pursuit of gain or the gratification of other passions, often sets it at defiance, and engages in bodily or mental labour both immediately before and after meals; but, in return, he receives his reward for despising the authority of nature, in a severity of suffering from which the animals whom he treats so much better than himself, are by his care entirely exempted. Nowhere, for example, does man hurry off to business so immediately as in the United States of America, and nowhere does he bolt his food so much as if running a race against time. The consequence is, that nowhere do intemperate eating and dyspepsy prevail to the same enormous amount. Even in England, according to Dr. Caldwell, the extent of transgression cannot be compared with what is witnessed

among our transatlantic brethren; and the result shows, that if we in Britain suffer from indulging our fondness for good things, the comparatively deliberate way in which we set about enjoying them, serves as a partial safeguard, and exempts us from a portion of the punishment which our brethren bring down upon themselves, by the hurry with which they first devour their food and then set off to work. Rapid eating almost invariably leads to overloading the stomach; and when to this is added a total disregard of the quietude necessary for digestion, what can be expected to follow but inveterate dyspepsy?

The reason why wounds, bloodletting, bathing, and other circumstances which tend to disturb the regularity of the circulation, are so hurtful after a full meal, will now be apparent. The effect of wounds and bloodletting is to give rise to an instantaneous change in the distribution of the blood, and to deprive the stomach of that which is now doubly required. Bathing, whether hot or cold, has an analogous effect; and so, indeed, have all violent and sudden bodily or mental shocks.

It must not, however, be imagined that the period of repose necessary to ensure healthy digestion extends over the whole time of the continuance of food in the stomach. After a moderate meal, and in ordinary health, the concentration of the vital powers in that organ, and their proportionate depression in other parts of the body, rarely continue, at least in a very marked degree, beyond the period usually allotted to the *siesta*, or sleep after dinner, in warm climates, and even in Italy and Spain—namely, an hour or an hour and a half. When the meal has not exceeded the bounds of moderation, *a sufficient quantity of gastric juice for the digestion of the whole is secreted generally within the first hour;* after which time, consequently, the same quantity of blood is no longer required to be directed towards

the stomach, but may beneficially be distributed to such other parts, as from their activity more immediately require its aid. If the muscular system is to be employed in labour or locomotion, the blood can now be spared to sustain its activity; if the mind is to be engaged in intellectual pursuits, it can be sent to the brain without robbing the stomach. The same principle of course applies to all the other organs; and it is therefore chiefly during the first hour, till all the gastric juice be provided and the chymification of the food be fairly commenced, that tranquillity of mind and inaction of body are so essential.

As already mentioned, the reality of increased circulation in the vessels of the stomach during digestion has been established by ocular demonstration, as well as by analogy. The increase in the supply of nervous energy which takes place at the same time is, however, scarcely less certain, although from its nature incapable of being seen. It is the almost characteristic feature of the nervous system to be excited by stimulus to increased action; and we formerly saw that when the nerves of the stomach are cut, and the flow of nervous influence is arrested, digestion instantly suffers. But the same principle holds in the nervous as in the circulating system. Energetic action cannot be kept up in two distant parts of the body at the same time. If the intellect be intently occupied in profound and absorbing thought, the nervous energy will be concentrated in the brain, and any demands made on it by the stomach or muscles will be very imperfectly attended to. If, on the other hand, the stomach be actively engaged in digesting a full meal, and some subject of thought be then presented to the mind, considerable difficulty will be felt in pursuing it, and most probably both thought and digestion will be disturbed. If the mental effort required be easy and agreeable, and the meal be a very temperate

one, there will be much less difficulty in simultaneously proceeding with both, because comparatively little nervous energy will then suffice for them. Still, however, each will go on more efficiently if not interfered with by the other.

When the mind is active and vigorous, and properly exercised in all its departments of feeling and affection as well as of intellect, the nervous influence which the brain produces is not only more abundant, but of a more healthful and invigorating quality. Hence the well-known preservative and restorative influence of cheerful dispositions and gratified activity of mind, and hence the depressing, morbid, and often fatal effects of corroding care, grief, or apprehension, on every organ of the body. Hence, too, the weak digestion and sallow complexions of literary men and hard students, who suffer severely from transgressing this law of the animal economy by habitually engaging in occupations requiring much exertion of mind, not only soon after, but even during the very act of swallowing their meals. Ignorant of the connection subsisting between the different functions, and of their laws of action, few can be convinced in time of the importance of observing this condition, even after its operation has been explained to them. In the conclusion, however, experience teaches many whose reason is insufficient for their guidance, and forces them to a closer conformity with the dictates of nature, when obedience is almost too late to be of benefit.

The prodigious influence of the nervous system on digestion is familiarly and unequivocally exhibited in almost every case of dyspepsy which each succeeding day brings under the notice of the physician. *He* knows well from experience that the diet may be selected with every care, its quantity duly proportioned, and exercise rigidly practised, and yet all his curative treatment fail even to re-

lieve, unless his patient be at the same time freed from the pressure of care, and due attention be devoted to the observance of mental and bodily repose after every meal. The heavier the meal the greater is the desire for absolute rest, and the less advantageously can active exertion be encountered. When the stomach is loaded, the whole vital energies seem to be concentrated in it to enable it to cope with the task imposed upon it. But when we eat temperately, there is less necessity for entire quietude of mind and body. Accordingly, if we do not experience the same dislike to exertion after a light forenoon lunch, which we do after a heavy late dinner, the reason is simply, that less gastric juice, less nervous energy, and less vigorous action in the stomach, are required to digest in the one case than in the other.

Among operative manufacturers, who are much within doors, and who are allowed only a few minutes for meals, indigestion is very prevalent. Ordinary labourers are better treated in this respect, as they are allowed one hour for breakfast and another for dinner. To most of them the walk to and from their own houses is almost as good as, if not better, than absolute rest, because it varies their position, is taken leisurely, and costs no effort.

Those who are compelled by circumstances to active exertion immediately after a meal, or whose minds are intently occupied in thought or emotion, will find their only safety in eating less than when differently situated. The stomach, having less labour imposed upon it, will require less blood and less nervous energy, and consequently less of both will be abstracted from the other organs, which are also in activity, and requiring their assistance. Travellers, literati, and other actively engaged men, know this rule by experience, and some of them have specially noticed its importance. Richard Cumberland, for example, in speaking of his own

habits, says: "Nature has given me the hereditary blessing of a constitutional and habitual temperance, that revolts against excess of any sort, and never suffers appetite to load the frame. I am accordingly as fit to resume my book or my pen the instant after my meal, as I was in the freshest hours of the morning."* This compatibility of temperate eating with activity did not escape the acute observation of Hippocrates.

The state of the mind, indeed, exerts a powerful influence not only on the stomach, but on the whole process of nutrition, and greatly modifies the quantity which may be safely eaten. If the mind be gay and joyous, appetite will be comparatively keen, digestion effective and rapid, and nutrition complete. Examples of this kind abound in childhood, and among an easy-minded, well-fed peasantry. Whereas if the mind be harassed by care and anxiety, or devoured by grief, envy, jealousy, or other troubles and disquieting passions, the healthy calls of appetite will be scarcely known, and digestion and nutrition will be equally impaired. This fact is exemplified on a large scale in every commercial country, and especially in times of *public distress* and *political change.* Shakspeare obviously had the principle in view when he made Cæsar exclaim—

"Let me have men about me that are *fat*,
Sleek-headed men, and such as sleep o' nights.
Yond' Cassius has *a lean and hungry look;*
He thinks too much: such men are dangerous.
Antony. Fear him not, Cæsar, he's not dangerous,
He is a noble Roman, and well given.
Cæsar. Would he were fatter: but I fear him not:
Yet if my name were liable to fear,
I do not know the man I should avoid
So soon as that spare Cassius. He reads much.
He is a great observer, and he looks
Quite through the deeds of men; *he loves no plays,*

* Cumberland's Memoirs, vol. ii., p. 204.

As thou dost, Antony; he hears no music,
Seldom he smiles, and smiles in such a sort
As if he mocked himself, and scorned his spirit
That could be moved to smile at anything.
Such men as he be never at heart's ease
While they behold a greater than themselves,
And therefore are they very dangerous."

Even experience must have taught every one with what zest we sit down to enjoy the pleasures of the table, and how largely we incline to eat, when the mind is free, unburdened, and joyous, compared with the little attention we bestow on our meals when we are overwhelmed with anxiety, or have the whole energies of the mind concentrated on some important scheme. There cannot be a doubt, indeed, that the over-exertion and excitement, or absolute inertness of mind, in which sedentary people are generally immersed, contributes greatly, along with the want of muscular exercise in the open air, to impair the tone of the digestive organs. In this way, as it is not less justly than forcibly remarked by Dr. Caldwell, "dyspepsy *commences*, perhaps, as often in the brain as in the stomach. Possibly oftener. That this is true of the disease in Europe will scarcely be denied, after a fair examination of the facts connected with it. It is there almost exclusively a complaint of the studious and the scheming, who, over-tasking their brains, injure them by toil. Among the husbandmen of England, who steadily pursue their tranquil mode of life, regardless of the fluctuations of stock, the bickerings of party, the fate of political measures, and the changes of place, dyspepsy is almost a stranger." "In the cities, the same is in a great measure true of merchants, manufacturers, and mechanics, who are engaged in a regular and well-established business, which is fully understood by them, where the risk is slight and the profits sure, and no disquieting anxiety attends it. Such individuals have a good

digestion, and bear the marks of it. But with literary men, officers of state, dealers in scrip, daring adventurers, and anxious and ambitious projectors of improvements, with these and every other brain-worn class of persons, the case is different. Dyspepsy is their torment, and they exhibit deep traces of it in their lean frames and haggard countenances. Yet are they much more select in their diet, both as respects quantity, quality, and cooking, than the classes to whom dyspepsy is unknown. This fact is notorious, and has been so for centuries. Nor can it be attributed, I think, to any other cause but excessive and deleterious cerebral irritation in the one case, and an exemption from it in the other; and this cause seems sufficient to solve the problem."*

In denouncing active exertion of mind or body immediately after eating, as inimical to digestion, it is not meant that we should go to sleep, or indulge in absolute listlessness. A weak constitution may require something like complete repose, but a person in ordinary health may indulge in a leisurely saunter or pleasant conversation, not only without injury but with positive benefit; and perhaps there is no situation in which digestion goes on so favourably, as during the cheerful play of sentiment in the after-dinner small-talk of a well-assorted circle. The nervous stimulus sent to the stomach is then of the most healthful and invigorating description; and even the dyspeptic, if on his guard against a heavy meal, forgets his woes amid the unwonted vigour of his functions.

It is true that thousands who habitually neglect the observance of the condition here adverted to, continue to live and digest for years without appearing to suffer much from their conduct. But it is not less true that there are many more who bring

* Caldwell's Thoughts on Physical Education, p. 94.

wretchedness and disease upon themselves and their offspring, in the vain attempt to counteract the intentions of nature, and that there are comparatively few, even of the former, so happily constituted as to escape entirely unscathed. Most frequently the evil consequences are only accumulating, and when they are summed up at the end of years, the victim finds himself more severely punished than he had ever expected to be. In this respect, the consequence resembles that arising from breathing in a vitiated atmosphere. The effect may not be perceptible for a time; but if God has ordained a pure air to be best adapted for respiration, we have the infallible authority of his omniscience for believing that one which is vitiated *must* be less wholesome, although his beneficence has so constituted us, that the injury resulting from it is gradual in its infliction, for the very purpose of giving us time to escape. In like manner, if bodily and mental relaxation are favourable to digestion, we have the same infallible guarantee that every departure from them *must* be in so far hurtful, however slowly the effect may develope itself.

CHAPTER V.

ON DRINKS.

Thirst the best guide in taking simple drinks.--Thirst increased by diminution of the circulating fluids.—The desire for liquids generally an indication of their propriety.—Much fluid hurtful at meals.—Most useful three or four hours later.—The temperature of drinks is of consequence.—Curious fall of temperature in the stomach from cold water.—Ices hurtful after dinner.—Useful in warm weather, when digestion is completed and caution used.—Cold water more dangerous than ice when the body is overheated.—Tepid drinks safest and most refreshing after perspiration.—Kinds of drink.—Water safe for every constitution.—Wine, spirits, and other fermented liquors, too stimulating for general use, but beneficial in certain circumstances.—Test of their utility.

On the subject of drinks two questions naturally occur. *When* ought we to drink? and, *What* ought we to drink? On both I shall offer a few very brief remarks.

In the first part of this volume I endeavoured to show that the sensation of *thirst* is given to us for the express purpose of impelling us to take liquids whenever the wants of the system require them, and that, in all ordinary circumstances, we cannot have a better or a safer guide. Such is the general case; but exposed as we are to numerous deviations from the intentions of nature in our ways of living, a few precautionary observations may not be without use.

The quantity of fluid separated from the blood and thrown out of the system, in the course of twenty-four hours, by perspiration, exhalation from the lungs, the urinary discharge, and the various

other secretions, is very great; and were not the loss as regularly supplied by the ingestion of liquid, either as food or as drink, the blood would speedily become so thick as to be unfit for circulation. This actually happens in Asiatic cholera, in which the watery portion of the blood is drained off through the bowels with frightful rapidity, and in which, consequently, the urgency of thirst is almost always excessive. In the healthy state, however, the loss of fluid is never too rapid unless under severe exertion or exposure to a very high temperature, both being circumstances in which it is well known that thirst becomes urgent in proportion to the necessities of the frame.

In proof of the sensation of thirst being greatly dependant upon the quantity of fluid circulating in the vessels, Professor Dunglison of Maryland refers to the fact, mentioned by Dupuytren, that he "succeeded in allaying the thirst of animals by injecting milk, whey, water, and other fluids into their veins;" and to Orfila's statement, "that, in his toxicological experiments, he frequently allayed, in this way, the excessive thirst of animals to which he had administered poison, and which were incapable of drinking, owing to the œsophagus having been tied. He found, also, that the blood of animals was more and more deprived of its watery portions as the abstinence from liquids was more prolonged;"* and hence the greater thirst naturally experienced under such circumstances.

As a general rule, then, the desire for liquids will in itself be an indication of their propriety; but in gratifying it, we should be careful not to drink so fast as either to distend the stomach beyond proper

* See Professor Dunglison's Elements of Hygiène, p. 324, in which the reader will find a great variety of very useful information on all the branches of the subject. The remarks on the different kinds of food and drink are among the best which I have met with.

bounds, or to disturb the progress of digestion by undue dilution too soon after eating. Many persons, from habit rather than thirst, impair the tone of the stomach by drinking largely during or immediately after meals, and thus relaxing the mucous coat, and probably affecting the quality of its secretions. If the gastric juice be greatly diluted by extraneous fluids, it is natural to suppose that its solvent power must be diminished; but whether this explanation be sound or not, the practice of drinking frequently is certainly hurtful, and therefore we ought to avoid it.

Experience proves that a moderate quantity of liquid during a meal is beneficial; and if we drink little at a time, the risk of exceeding the proper limit will be very small. Dyspeptics, however, ought to be on their guard against taking too much, as they are apt to be misled by uneasy sensations in the region of the stomach, which are relieved for the moment, but afterward aggravated, by the free dilution of the food. Those, also, who live well, and are in the habit of taking wine daily, whether the system requires it or not, often fall into the error of excessive indulgence in liquids to mitigate the thirst and irritability which the unnecessary use of stimulus never fails to induce, especially at night. The continual dilution, however, adds to the mischief, by increasing the debility of the stomach, and, as pointed out in the chapter on thirst, the only effectual remedy is to adapt the diet and regimen to the real wants of the constitution. Except in disease, a continually recurring thirst must proceed from mismanagement, and it is to be satisfied by an improved and rational regimen, and not by oceans of fluid, which only weaken the stomach still more, and aggravate the craving they are meant to cure.

The opinion is very prevalent, that mild drinks may be taken with most advantage about three or four hours after a solid meal; and, certainly, the al-

most universal use of tea or coffee about that time appears to sanction its soundness. Theoretically, too, we might expect this result; for digestion is then nearly over, and any food remaining in the stomach is already in a fluid state. Many objections, however, have been made to both tea and coffee as an evening beverage; but most of them seem to me to apply to their undue quantity and strength rather than to their temperate use. When made very strong, or taken in large quantity, especially late in the evening, they not only ruin the stomach, but very seriously derange the health of the brain and nervous system.

The question of drink is of little importance as regards breakfast. During the night, the chief expenditure of the system—by perspiration, urine, and exhalation from the lungs—is of a fluid nature, and hence there is a marked and general preference of fluids as a part of our first meal. In this country, accordingly, tea, coffee, and chocolate are in almost universal use for breakfast, and no other liquid is required merely as drink. If, from the mode of life or other causes, thirst be excited in the forenoon, no valid objection can be urged against its moderate and reasonable gratification.

The *temperature* at which liquids are taken is a matter of perhaps greater consequence than it is usually considered. As regards the teeth, we have already seen that either very cold or very hot substances coming in contact with them are apt to be injurious. As regards the stomach, the same principle holds true; and when we consider the multitude and intricacy of its nervous connections with other vital organs, we cannot be surprised at even sudden death being frequently caused by drinking ice-cold water when the body is weakened by profuse perspiration. Of the various subjects connected with digestion on which Dr. Beaumont has thrown light by his experiments on St. Martin, this is one of

the few which he has omitted to investigate with his usual diligence and accuracy; a circumstance which is the more remarkable, because an incidental observation of his own seems, from its singularity, to have been well calculated to direct his attention to its consideration. On the occasion alluded to, when a gill of water, at the temperature of 55° Fahr., was received into the empty stomach, in which the thermometer previously indicated a heat of 99°, Dr. Beaumont remarked that it immediately diffused itself over the interior surface, and *brought down the temperature to* 70°, at which it stood for a few minutes, and then began again to rise very slowly. *It was not till thirty minutes had elapsed, and all the water been for some time absorbed, that the mercury regained its former level of* 99°. This is an important fact, and it is curious that Dr. Beaumont did not think of following it up by a regular series of experiments, to ascertain the effects of cold and hot drinks on the progress of digestion and on the general system. It is well known, for example, that a copious draught of cold water, taken in a state of perspiration and fatigue, is often instantly fatal; but its operation has never been satisfactorily explained. The above experiment, however, throws some light on it; for if a single gill of water at 55° (which is not by any means a low temperature) is able to reduce the heat of the stomach in a moment by no less than *twenty-nine degrees*, when neither fatigue nor perspiration is present to add to its effect, the influence of a *large quantity*, such as is usually drunk by harvest labourers and others who die of it, and at a still lower temperature, must undoubtedly be much more powerful and permanent, especially when the bodily energies and means of resisting the shock are impaired by previous labour and exhaustion under a burning sun. In these cases the shock necessarily arising from such a sudden and extensive fall of temperature is greatly

increased by the position of the stomach in the very centre of the vital organs, to all of which it is most intimately linked by the numerous nervous connections given for the express purpose of extending the range and directness of its sympathies.

Keeping in mind the great depression of temperature caused by swallowing so small a quantity of cold water, and also the ascertained fact that a heat of about 100° is requisite for healthy digestion, we shall have no difficulty in accounting for the frequent injurious consequences arising from considerable quantities of ice-cream being hastily eaten, as they often are, at the end of a substantial dinner. The immediate effects of the rapid abstraction of heat to which they give rise in the stomach, are the instantaneous contraction and diminished action of its blood vessels, the consequent stoppage of the gastric secretion, diminished sensibility of its nerves and muscular fibres, and, lastly, disturbance of the heart and neighbouring vital organs, both by sympathy and by the direct abstraction of their heat. Such, at least, are the consequences which flow from the application of cold to parts exposed to observation, and partially verified by Dr. Beaumont in the case of the stomach; and if the analogy holds throughout, as there is every reason to believe, we cannot wonder that the free use of ice-cream at the end of a good dinner or supper should retard and even arrest digestion in a person delicately constituted.

In thus condemning the free use of ices at the end of a substantial meal, I do not, however, mean to say that a few teaspoonfuls of them, eaten slowly, and allowed to acquire a higher temperature before reaching the stomach, will do permanent injury to a person in health and in the enjoyment of sound digestion. Many eat them in this way and are little the worse; partly from the subsequent reaction being sufficient to counteract the depressing influence, and partly from a person in vigorous health

being able to throw off causes of disease from which those who are less robustly constituted suffer severely. My belief, however, is, that the *tendency* of ices, taken in such circumstances, is to produce mischief. A healthy person, for example, may possess vigour enough to escape injury from immersion in cold water, caused by the ice giving way when skating; but as well might it be inferred, on that account, that a similar immersion would be generally innocuous, and even salubrious, as that all may safely eat ices freely because a given individual has done so with impunity. Dr. Beaumont's experiment with the cold water shows clearly that the effect is to *lower the vital tone* of the stomach; and, such being the case, those whose digestion is weak ought to be careful against impairing it still further by the use of ices. In some instances, however, it is not improbable that they help to neutralize the bad effects of hot soup, and other dishes eaten at too high a temperature.

The use of cold or iced water in hot weather and in warm climates, *when digestion is not going on* and *exhaustion is not present*, is so far from being necessarily hurtful, that with proper caution it may prove both grateful and refreshing. In Italy, accordingly, ice is considered so much a necessary of life in summer, that in Naples and other places the confectioners are punished by a fine if they allow their supply to fall short. In Virginia, too, where, we are told by Professor Dunglison, it was very common some years ago for the labourers in the harvest field to be killed by drinking copiously of spring water while overheated, cases of death have become extremely unfrequent since the custom was introduced of supplying them with ice. When water was taken, it was always hastily and in large quantity, so that the immediate effect on the system was greater than could possibly arise from the small quantity of ice which is required for

quenching thirst. The very slowness, indeed, with which ice melts, not only prevents much being taken, but causes the water procured from it to reach a higher and safer temperature before it arrives at the stomach.* Hence, when ices are taken, the more slowly they are eaten the more refreshing and salubrious will they become, because the less violent will be their action upon the nerves, blood vessels, and membranes of the stomach. From the close sympathy existing between the stomach and the skin, a single teaspoonful of ice-cream suddenly swallowed when the body is weak and perspiring, will produce as instantaneous a sense of chill as a pail of cold water dashed over the surface; and on account of this very power over the vital actions of the stomach, ice has of late been cautiously and beneficially prescribed to subdue inflammation of that organ.

Liquids, such as soup, tea, and coffee, taken at a very high temperature, also are injurious, but not in the same degree. They relax the mucous membrane and weaken the action of the muscular coat, and in so far tend to impair digestion. The fittest temperature for both solid and liquid food is perhaps about the natural heat of the body, or a little above 100°. Dr. Dunglison, however, and some other physiologists, regard hot fluids as stimulating to the stomach, and therefore conducive to digestion; but he admits that debility is their ultimate effect.

When great thirst has been excited either by bodily labour or by external heat, it will generally be more effectually as well as safely quenched by drinking moderately of tepid than of cold fluids. A tepid draught—a cup of tea for example—produces no disturbing action in the stomach, and, being immediately absorbed, supplies the deficiency of liquid without changing the balance of the circula-

* Dunglison's Elements of Hygiène, p. 331.

ting fluids, thus relieving thirst very much in the same way as Dupuytren did by injecting tepid water into the veins; whereas cold drink, by the suddenness of its impression, disturbs the balance of the circulation, and excites a degree of reaction which increases the original discomfort. If the system is at the same time weakened by fatigue, cold drinks are always injurious.

Of late years a change in the treatment of horses in this respect has taken place. Formerly it used to be considered dangerous to give water to a horse in a state of perspiration. Now, however, it is a common practice to allow post and stage-coach horses a little water before their run is completed, however warm they may be: but, in the first place, the quantity allowed is small, and is always given before the strength is exhausted; and, in the second place, the excitement of the subsequent exercise prevents any considerable disturbance in the balance of circulation, and thus ensures the safety of the animal. If even the same moderate quantity were given at the end of the stage, and the horse were then allowed to rest, inflammation would almost inevitably result.

The same principle applies to the human frame, and affords an easy explanation of the occasional instances we see of persons *heated* by exertion drinking cold water without injury, If the exertion have been merely sufficient to produce *excitement without fatigue*, and *heat without debilitating perspiration*, and especially if it be resumed after the draught, little or no harm will ensue. But if exhaustion or fatigue have been induced, and the individual be allowed to drink freely of the cold water and then rest, the probability of mischief resulting from it will be greatly increased. Many accidents result from losing sight of this distinction, and from acting alike in circumstances so essentially different.

On the subject of *the kind of drink* which ought to be taken a great deal might be said, were it necessary to discuss here the qualities of all the liquors that are in use. But as my purpose is very different, a few general remarks will be enough.

Water is a safe drink for all constitutions, provided it be resorted to in obedience to the dictates of natural thirst only, and not of habit, and with the precautions already pointed out; but unless the desire for it is felt, there is no occasion for its use during a meal, for the mere purpose of obeying a general rule. Toast and water, whey, beer, barley water, aerated and soda water, and other liquids of a similar kind, which are little stronger than pure water, may be used, according to the same general principle, by those who prefer them and find them agreeable to the stomach. But with regard to such fermented liquors as porter, ale, spirits, and wine, much greater restriction is necessary, because much good or evil may be done by them when properly or improperly administered.

The primary effect of all distilled and fermented liquors is to *stimulate the nervous system and quicken the circulation.* In all conditions, therefore, in which the action of those requires to be increased or supported, they are calculated to be useful; and, on the contrary, where it requires to be soothed and abated, they are sure to be prejudicial. To show the utility of this principle as a standard, we shall notice a few of its applications.

Among the higher classes, it is common to give children an allowance of wine every day from a very early age. To determine the propriety of doing so, let us examine what is then their constitutional state.

In infancy and childhood the circulation is rapid and easily excited, and the nervous system is strongly acted upon even by the slightest external impressions. Hence slight causes of irritation

readily excite febrile and convulsive disorders. The object of the parent, therefore, is not to stimulate, but rather to *abate* nervous and vascular action. Wine, accordingly, is not only unnecessary, but *positively detrimental to children*, and it is wrong to accustom them to it. There are individual children, no doubt, who are so imperfectly constituted as to require some stimulus to rouse the system to healthy action, and to whom wine is beneficial as a medicine. But these are the exceptions to the general rule, and to them it should be given only under medical sanction.

In youth the natural tendency of the constitution is still to excitement; and consequently, as a general rule, the stimulus of fermented liquors is injurious. During rapid growth, however, the animal functions are sometimes so enfeebled by the great demands made upon them, that not only a full supply of nourishing food, but also an allowance of wine or malt liquor is required for a time to sustain their energy. In this case the beneficial influence of the fermented drinks is apparent, by their giving tone to the system without raising the pulse or increasing nervous sensibility; but whenever any of these effects is produced, their employment ought to be discontinued.

In mature age, when digestion is good and the system in full vigour, if the mode of life be not too exhausting, the nervous functions and general circulation are in their best condition, and require no stimulus for their support. The bodily energy is then easily sustained by nutritious food and a regular regimen, and consequently artificial excitement only increases the wasting of the natural strength. Where, however, the system has been long accustomed to the use of wine, it will, in general, be better to leave it off gradually than to make a sudden change. In old age, when the powers of life

begin to fail, moderate stimulus may be used with evident advantage.

If it be said that this doctrine amounts to a virtual prohibition of wine and stimulant liquors, I admit at once that, where the whole animal functions go on healthfully and energetically without them, their use is, in my opinion, adverse to the continuance of health. But there are many constitutions so inherently defective in energy, as to derive benefit from a moderate daily allowance of wine; and there are many situations in which even the healthiest derive additional security from its occasional use. If, for example, a healthy person is exposed to unusual and continued exertion in the open air, or to the influence of anxious and depressing watchfulness, a moderate quantity of wine along with his food may become the means of warding off actual disease, and enabling him to bear up uninjured, where without it he would have given way. This preservative influence has been so often experienced, that it is impossible to deny its reality.

While, then, I consider stimulating liquors of every kind as both useful and hurtful, where without them the system is healthful and energetic, I can see no reason why their temperate use in circumstances of an opposite nature ought to be denied. Many weak constitutions and many invalids are benefited by wine, and all that can reasonably be demanded is, that it shall not be abused.

Continued and severe exertion, whether of body or of mind, often exhausts the system so much as to render the temporary use of wine, and even of spirits, not only innocuous, but positively beneficial; but in these cases they should be considered as medicines, and care ought to be taken not to carry the stimulus too far. That, in some circumstances, stimulus is really required, is accordingly shown by the ease with which the system bears its effects. I have known a delicate lady, during recovery from

fever, take to the extent of a bottle of Madeira in twenty-four hours, without producing the least undue excitement of either the mind or the pulse, but rather the contrary—it soothed the mind and reduced the pulse; and this I take to be the true test of its propriety in all circumstances.

The same principle explains the well-known fact that many sportsmen, who, while living a sedentary life in town, are easily effected by even a small quantity of spirits, yet bear triple the quantity, with apparent impunity, under the influence of inspiriting exercise in a pure mountain air. On resuming their former habits, the spirits again affect them as readily as before.

As a support to the system in cases which require it, wine is in general far preferable to spirits of any description. The former, when seasonably used, communicates a more healthful and permanent tone to the frame; while spirits impart a strong and unnatural stimulus, which is sooner or later followed by collapse and debility—and hence the incessant craving for more when the system has once been accustomed to them. Ardent spirits, therefore, ought to be used only as a medical remedy. At present, however, this is so far from being the case, that they are resorted to on all occasions, afflictive and convivial, as if they were a specific against every evil. Among the poor, especially, whiskey or gin is considered a sovereign remedy for every disease. Even to infants it is administered with a recklessness which savours strongly of barbarism, and the consequences are as might be expected—deplorable. Among the higher classes, too, brandy and strong stimuli are in more frequent use than they ought to be; and medical men should be on their guard against directly or indirectly encouraging, in their patients, a practice so utterly destructive to both physical and moral happiness. For, in some instances, it is to be feared that the

stimulant bitters and anti-spasmodics, so generally had recourse to in indigestion and nervous diseases, have had an unsuspected share in the formation of a habit of intemperance.

Of late years, great exertions have been made, both in this country and in America, to warn the public against indulging in the use of ardent spirits; and powerful medical as well as moral facts and arguments have been adduced to demonstrate the unspeakably greater advantages of temperance. These efforts have been followed with astonishing success, and the good which has been already effected is immense. It seems to me, however, that much more might be accomplished, if we did not confine ourselves so exclusively to the mere inculcation of abstinence from intoxicating liquors, but concerned ourselves more in improving the general character, as the surest road to reformation, and in providing resources by means of which the reformation, when once effected, might be fully confirmed. The temperance which is produced by elevation of mind, and an improved state of moral feeling, will be not only much more beneficial in its consequences, but infinitely more proof against temptations, than that which is observed merely in fulfilment of a vow; and unless something be made to come in the place of the enjoyment which is withdrawn, the danger of a relapse will continue to be great. The importance of this principle is perhaps not sufficiently recognised in the otherwise valuable labours of temperance societies.

Many persons imagine that spirits, taken in moderate quantity, cannot be injurious, *because they feel no immediate bad effects from their use.* If the fundamental principle which I have advanced is sound, and if all the functions of the system are already vigorously executed *without* the aid of spirits, their use can be followed by only one effect—*morbid excitement;* and it is in vain to contend

against this obvious truth. The evil attending their unnecessary use may not be *felt* at the moment, but nevertheless it is there; and for demonstrative proof of the fact, we are again indebted to Dr. Beaumont. On examining St. Martin's stomach after he had been indulging freely in ardent spirits for several days, Dr. Beaumont found its mucous membrane covered with *erythematic* (inflammatory) *and aphthous* (ulcerous) *patches*, the secretions vitiated, and the gastric juice diminished in quantity, viscid, and unhealthy; although St. Martin still *complained of nothing*, not even of impaired appetite. Two days later, when the state of matters was aggravated, "*the inner membrane of the stomach was unusually morbid, the erythematic appearance more extensive, the spots more livid than usual; from the surface of some of them exuded small drops of grumous blood; the aphthous patches were larger and more numerous, the mucous covering thicker than common, and the gastric secretions much more vitiated. The gastric fluids extracted were mixed with a large proportion of thick ropy mucus, and a considerable muco-purulent discharge slightly tinged with blood, resembling the discharge from the bowels in some cases of dysentery.* Notwithstanding this diseased appearance of the stomach, no very essential aberration of its functions was manifested. St. Martin complained of no symptoms indicating any general derangement of the system, except an uneasy sensation and a tenderness at the pit of the stomach, and some vertigo, with dimness and yellowness of vision, on stooping down and rising again; had a thin yellowish-brown coat on his tongue, and his countenance was rather sallow; pulse uniform and regular, appetite good; rests quietly, and sleeps as usual."*

I have marked part of this quotation in italics, because it cannot be too attentively considered by

* Beaumont's Experiments and Observations, &c., p. 237.

those who contend that the stimulus of spirits is not injurious to the stomach or general health, unless where the mischief shows itself by palpable external signs. Here we have incontestible proof, that disease of the stomach was induced, and going on from bad to worse, in consequence of indulgence in ardent spirits, although no prominent symptom made its appearance, and St. Martin was in his general habits a healthy and sober man. And if such be the results of a few days of intemperance in a person of a sound constitution, it is impossible to deny that continued indulgence must be followed by more serious evils, whether these show themselves from the first by marked external signs or not.

After a few days of low diet and the use of mild diluents, the coats of St. Martin's stomach were seen to resume their healthy appearance; the secretions became natural, the gastric juice clear and abundant, and the appetite voracious. Dr. Beaumont adds, that, in the course of his experiments, diseased appearances of a similar kind were frequently observed—generally, but not always, after some appreciable cause. "Improper indulgence in eating and drinking has been the most common precursor of these diseased conditions of the coats of the stomach. *The free use of ardent spirits, wine, beer, or any intoxicating liquor, when continued for some days, has invariably produced these morbid changes. Eating voraciously or to excess, swallowing food coarsely masticated or too fast,*" "almost invariably produce similar effects, if repeated a number of times in close succession."—(P. 239.) These observations require no comment; their practical bearing must be obvious to all who are willing to perceive it.

Dr. Beaumont had also frequent occasion to remark, that, when stomachic disorder, attended with febrile symptoms, was present, the mucous coat of the stomach presented distinct appearances

of disease. He frequently saw it, for example, red, irritable, and dry; and on the food touching it, *no gastric juice exuded*, and consequently any food taken lay long undigested. But after the diseased action was subdued by regimen and medicine, the gastric juice again flowed readily, and digestion went on as vigorously as before. Even anger and violent mental emotions sometimes produced these appearances, and gave rise to temporary indigestion. These observations show the futility, not to say mischief, of administering food during fever and other diseases by way of supporting the strength, when, from the deficiency of the gastric juice, it cannot be digested, and can only add to the existing irritation. In this state, however, bland fluids are appropriate; because they allay irritation, and are almost entirely absorbed without requiring to be digested.

The condition of the stomach above described, and the consequent failure and vitiation of the gastric secretion, induced by drinking ardent spirits, and by general intemperance, explain at once the miserable digestion and impaired appetite of the habitual drunkard; and it would be well for those who are in danger of becoming the victims of the habit, were they early impressed with some of these striking and important truths.

If it be asked whether I go the length of proscribing all fermented liquors, from table beer upward, I answer that I do not; I merely mean, that, where the general health is perfect without them, they ought not to be taken, because then their only effect is to produce unnatural excitement. But wherever the constitution or health is so deficient, or the exertions required by the mode of life are so great, that the system cannot be sustained in proper vigour without some additional stimulus, I would not only sanction but recommend the use of either

wine or such other fermented liquor as should be found by experience to support the strength, *without quickening the circulation*, *exciting the mind*, *or disordering the digestive functions*. If, however, any of these effects be produced, I would consider its occurrence as a proof that the stimulus is inappropriate, and cannot be too soon discontinued, or at least diminished to such a quantity as shall be consistent with the ordinary action of the animal functions.

It may be alleged that a glass of brandy after a heavy dinner facilitates digestion, and therefore cannot do harm. I admit at once, that, when we eat too much, or fill the stomach with indigestible food, a dram of brandy, from its temporary stimulus, enables us to get rid of the load sooner than we could do without it. But it seems to me, that a far wiser plan would be, to abstain from eating what we know to be oppressive to the stomach; and that, by this means, we shall attain our end infinitely better, than by first eating a heavy meal and then taking a stimulus, the efficacy of which is diminished by every repetition of its use. If we were *compelled* to exceed the bounds of moderation in eating, there would be some apology for our conduct.

CHAPTER VI.

ON THE PROPER REGULATION OF THE BOWELS.

Functions of the intestines.—The action of the bowels bears a natural relation to the kind of diet.—Illustrations.—And also to the other excretions.—Practical conclusions from this.—Different causes of inactivity of bowels.—Natural aids to intestinal action.—General neglect of them.—Great importance of regularity of bowels.—Bad health from their neglect.—Especially at the age of puberty.—Natural means preferable to purgatives.—Concluding remarks.

Having now taken a general view of the objects, nature, and laws of digestion, and of the structure and mode of action of the various organs concerned in its performance, and made ourselves acquainted with the principles on which our conduct ought to be regulated, so as to second the intentions of nature for our welfare and happiness, I have only to add a few practical remarks on the proper management of the bowels, and then conclude.

The proper uses of the intestines are, as we have seen, to serve, 1*st*, for the performance of chylification; 2*dly*, for the absorption of the nutritive chyle; and, 3*dly*, as a reservoir for the indigestible residue of the food, and an outlet for both it and the effete matter which requires to be thrown out of the general system. The processes of chylification and absorption having been treated of in a former chapter, it is in the last capacity only we have now to consider the intestinal canal.

Besides the bowels, there are several other channels by which the waste materials of the body pass

out. The most important of these are the skin, the lungs, and the kidneys; and in certain circumstances, where the action of the one is impaired or repressed, the natural alliance subsisting among their respective functions, enables the rest to come to its assistance, and even for a time to supply its place. Thus when, by continued exposure to cold, the exhalation from the skin is much diminished, the blood is thrown in upon the internal organs in larger quantity, and, as a consequence, the urinary secretion and the exhalation from the lungs are both increased, and full relief to the system is temporarily obtained. During hot weather, on the other hand, when the skin is in high action, and perspiration flowing freely, the urinary secretion is greatly lessened. The same principle applies equally to the case of the bowels; and hence the sudden application of cold to the surface of the body, and consequent suppression of perspiration, often increase the intestinal secretions to such an amount as to induce bowel complaint. On the other hand, the excited action of the bowels by laxatives, tends equally to diminish the activity of the skin; and hence, indeed, one source of the *cooling* effect of saline purgatives administered in fever and inflammations.

The bowels being thus the outlet of the indigestible portion of the food, and of waste matter from the system, it follows that, in health, their action ought to bear a relation to the kind of aliment used, and to the state of the other excretory functions; and consequently, that what may constitute healthy action at one time, and in one individual, may be very far from presenting the same character at another time, and in a different individual. If, for example, a person be fed chiefly on milk, rice, or farinaceous aliment, which is almost entirely appropriated to the purposes of nutrition and leaves very little residue, the bowels, having little to throw out,

will naturally act seldomer and less fully than when the diet consists chiefly of bulky and innutritious vegetables, which leave a large portion of indigestible matter to be evacuated. Most persons are aware of the difference of effect between the two kinds of diet, but, from not being acquainted with the principle on which it depends, are apt to conclude that, because in the first case the bowels act less, therefore they ought to be assisted by laxatives. The inference, however, is by no means necessarily sound; because the diminished intestinal action consequent on an exclusively farinaceous diet is then the natural and healthy result; and accordingly, *where such diet is required*, the mere costiveness is attended with no injury to the constitution. The proper conclusion to be drawn from it is, that the permanent and exclusive use of concentrated food is not in harmony with the structure and functions of our digestive and assimilating organs, and that, therefore, instead of continuing their use, and merely resorting to purgatives to excite an action for the removal of a residue which does not exist, reason requires that we should select a diet better adapted to the constitution and laws of the organization by which it is to be acted upon.

The same remark applies to those who are accustomed to dine chiefly on animal food, and rice or bread, without any sufficient admixture of herbaceous or other innutritious substances. If, in such circumstances, the aliment is almost entirely converted into nourishment and absorbed, it follows, as a matter of necessity, that little will remain to be thrown out of the body, and that the bowels will act less than with a different kind of diet. If the state of the constitution at the time be such as to require the exclusive use of this kind of aliment, forced action of the bowels by purgatives will not be needed, because their slowness will be natural and healthy. But if it be not, then the proper remedy

is not to excite the bowels by irritating purgatives, but to remove the cause of the intestinal inactivity by changing the system of diet.

It may be answered to this, that there are many instances in which the stomach is unable to digest any vegetable or innutritious food, and in which. conseqently, the diet cannot be altered without injury. I admit that, in the present state of society, cases of this kind are common; but their number would be greatly reduced if a proper mode of life were systematically adopted, and that regard paid to the conditions of health which their intrinsic importance deserves. There are very few individuals who, when in health, and with the aid of a proper regimen, cannot digest aliment suited to the natural constitution of the stomach and bowels; and when such cases do occur, they constitute exceptions to the general rule, and must, of course, be treated either by the use of laxatives, or such other remedies as the circumstances may require.

As the frequency and amount of the intestinal evacuations may thus vary according to the nature of the diet, without necessarily involving any disturbance of health, so may they also vary according to the state of the other excretions; and hence, again, is evident the absurdity of considering the same standard as applicable alike to all persons, times, and circumstances. If, from continued exertion, perspiration is kept unusually active, the excretion from the bowels may be proportionally diminished, not only without injury, but even with advantage to the health; because, if the same waste were to go on by the bowels as before, and the increased exhalation from the skin also to continue, the system would speedily become reduced. In consumption, for example, exhausting bowel complaint and profuse perspiration are frequently observed to alternate, and whatever remedy is given to check the one generally aggravates the other

But if *both* were to run their course together, instead of singly, how much more rapidly would the system be undermined!

From this relation between the different excretory functions, it follows, that when sluggishness of the bowels is induced by excess in another excretion, the first step ought to be to remove or diminish the unnatural stimulus which has occasioned that excess, before attempting, by means of purgatives, to *force* the bowels to act. If the cause which has produced the deviation from the due proportion of the excretion be left unabated, the only effect of strong laxatives will be, not to relieve, but to irritate and weaken.

The mere fact of the bowels not being emptied so frequently as usual, is therefore, when taken by itself, no evidence that they ought to be stimulated by medicine. Before coming to this conclusion, we ought to determine clearly whether the diminished action results from morbid sluggishness of the intestinal canal, or is the natural result of an accidental change of diet, or temporary excess in the other excretions; because the remedy which is appropriate and efficacious in the one case, may be altogether inapplicable to the other. Where it arises entirely from the aliment leaving little residual matter to be thrown out, the health may suffer *from the diet being inappropriate*, but it will not suffer merely from the diminished action of the bowels. Whereas, when the diet is of the ordinary mixed kind, and the costiveness proceeds from morbid inaction, then general derangement of the system will be induced, unless the bowels be attended to, and their natural action restored. This distinction ought never to be lost sight of.

Judging from the prevalent notions on the subject, from the universal reference of all kinds of bad health to derangement of the stomach and bowels as their source, and from the scarcely less universal

use of purgatives as remedial agents, one would be apt to suppose that, to ensure health and long life, nothing more was required than to procure, no matter by what means, an intestinal evacuation regularly every day; and the inference would, to a certain extent, be confirmed by the acknowledged extensive utility of laxative medicines. The real state of the case, however, is not quite so simple; and as it is of importance that it should be understood, I shall attempt to explain it as clearly as I can.

We have seen that inactivity of the intestinal canal may arise from the use of too concentrated aliment, and from excess in the other excretions. In the great majority of cases, however, the cause is very different. In general, the diet is sufficiently varied and abundant, and the balance of functions sufficiently equal to leave a considerable quantity of alimentary residue and effete matter to be thrown out by the bowels; and if it is not regularly expelled, some obstacle of a different kind must exist, which, in the first place, ought to be removed, before we can expect to succeed in restoring the natural action. To learn how we may discover what that obstacle is, let us turn our attention for a moment to the natural means by which the intestinal evacuations are effected.

The progress of the intestinal contents along their canal depends, first, on their affording the necessary stimulus to excite the contraction of the muscular coat; secondly, on the assistance derived from the free action of the abdominal and respiratory muscles, not only during respiration, but during every kind of bodily exercise; and, thirdly, on the inner surface of the intestine being duly lubricated with the mucous secretion. If any or all of these conditions be unfulfilled, the inevitable result will be morbid sluggishness of the intestinal action, and the various consequences dependant on it; and hence, when

the evil exists, the first point to be determined is the nature of the cause by which it is produced.

As already remarked, farinaceous and other concentrated aliments do not afford the requisite stimulus to the muscular fibres of the intestine; because they are in a great measure absorbed, and leave little to be thrown out. If, therefore, concentrated food be the cause of costiveness, the proper remedy is to alter the diet, and to have recourse to other means only where that proves insufficient.

Where, however, as most frequently happens, the constipation arises not so much from an inappropriate diet as from the absence of all assistance from the abdominal and respiratory muscles, the first step to be taken is again to solicit their aid—first, by removing all impediments to free respiration, such as stays, waistbands, and belts; and, secondly, by resorting to such active exercises as shall call the muscles into full and regular action: and the next is to proportion the quantity of food to the wants of the system, and to the condition of the digestive organs. If we employ these means systematically and perseveringly, we shall rarely fail in at last restoring the healthy action of the bowels with little aid from medicine. But if we set these natural conditions at defiance, we may go on for years, adding pill to pill and dose to dose, without ever attaining the end at which we aim.

How, indeed, can it be otherwise? If the Creator has so constituted us that the free play of the lungs and muscles is indispensable to proper intestinal action, it is in vain for us to struggle against the arrangement, and expect to substitute beneficially the stimulus of purgatives for that of the natural play of the muscles. Either we must give up our own obstinate adherence to sedentary pursuits and conform to the Divine laws, or we must submit to the punishment inseparable from disobedience, and

merely endeavour to mitigate its severity by such partial remedies as lie within our reach.

Where bodily weakness, or any other cause, absolutely prevents us from engaging in active bodily exertion, continued kneading and rubbing over the region of the bowels, when used daily and persevered in till the strength is restored, is of great service in promoting their healthy action. Where great sluggishness of the bowels exists, and no exercise can be taken, the rubbing generally requires to be continued for an hour or more daily, or even twice a day.

The observance of a proper adaptation between the quantity of the food and the state of the digestive organs and mode of life, is not less essential to the proper action of the bowels than to that of the stomach. If the quantity be too great, the bowels become oppressed and weakened by their load; and it is in such circumstances that purgatives afford immediate relief by the removal of the superfluity, and, by blinding the individual to the real nature of the evil, tempt him to recur too frequently to the use of medicine.

Sometimes intestinal inaction proceeds from defective mucous secretion on the surface of the internal coat, caused either by errors in diet or by local irritation. When costiveness is excited in this way, a mild diluent regimen will generally remove it. It is in such cases that saline medicines, which act by increasing the mucous secretions, are often very useful; while aloetic and other stimulant purgatives increase the evil by aggravating the irritation.

Such being the mode of action of the bowels, and such the natural agents by which it is carried on, we can now appreciate the folly of seeking to apply the same remedy to every kind of costiveness, no matter from what cause it proceeds If a clerk

who sits motionless all day in an office, who indulges his appetite, and has no bodily exercise to facilitate respiration and give a natural impetus to the bowels, begins after a time to complain of constipation, it is not difficult to tell what is required for his cure. The first step which a knowledge of the animal functions suggests, is to diminish the quantity of food; the next, to use such a diet as is calculated to excite the muscular coat of the intestine to healthy activity; the third, to seek the natural aid arising from exercise of the abdominal and respiratory muscles; and the last of all, to have recourse, when necessary, to such medicine as may be required for a time to restore the tone of the bowels. and enable them to act without further assistance The course usually adopted, however, is widely different from that here described. From ignorance of the laws of organization, the patient is not aware of the extent to which he infringes them in his conduct, and consequently rests satisfied with lamenting his hard fate in possessing such a bad constitution, and resorting to strong medicines to *force* that action which he feels to be essential to health, but which he will not consent to elicit by the means with which nature has furnished him.

Among the middle and higher classes, very many females act on the same erroneous plan, and with equally unfortunate results. In them the evil is aggravated by the tightness of their clothing impeding almost entirely the descent of the diaphragm, and the free play of the abdominal muscles, in respiration.

From this view of the nature and causes of costiveness, it will be evident, that, as a general rule, the bowels are perfectly competent to the discharge of their functions, when the conditions essential for their healthy action are duly fulfilled. And hence whenever they become morbidly inactive, we may

rest assured that, in some point or other, our own management is or has been defective; and the surest way to remedy the evil is, not to have instant recourse to medicine, but to begin by discovering and amending the defect. In the rare occurence of constipation among children and other actively employed persons, we have ample proof of the fundamental principle that the bowels do not naturally stand in need of the stimulus of medicine, but require only to be properly treated to fit them for the office with which they are charged.

While, then, I entirely agree with public opinion in attaching great importance to the proper regulation of the bowels, and in tracing much suffering to their neglect, I am only the more anxious that we should, as far as possible, follow nature in our arrangements and reap the benefit of her aid. If we do so, we shall not only be less frequently obliged to have recourse to medicine, but, by our knowledge of the causes of the deficient action, be greatly assisted in our selection of an appropriate kind of laxative, and thus avoid forcing the constitution too far. It sometimes happens, for example, that from debility of the muscular coat, the peristaltic motion is insufficient to propel the contents of the intestines even with the aid of proper diet and exercise. In such cases, small doses of aloes or rhubarb, or other laxatives which act chiefly by exciting the muscular contraction, will be sufficient to clear the bowels, especially when any mild tonic is conjoined with them: while saline laxatives, which act chiefly on the mucous coat, may be given freely, and even cause numerous watery evacuations, and yet the real or solid contents of the intestines continue unremoved. In practice this often happens; and hence the frequent mistake of supposing that there is proper passage from the bowels, when in reality there is no such thing.

The period of life at which intestinal inactivity is attended with the most serious consequences, is at and for a few years after puberty. At that age a sudden change is often made from the restless activity of youth to all the stillness of a sedentary profession, without any corresponding alteration being made in the quantity of food consumed. The vigorous appetite, which is perfectly natural during a period of growth and great bodily activity, remains at first unimpaired, and impels the individual to eat an amount of food far beyond the present necessities of the system. The consequence is a tendency, not only to fulness from excessive nutrition, but to severe digestive disorder from the stomach and intestines being weakened both by want of exercise and by excess of food. I have known many instances of dyspepsy, constipation, and mental affection, and even of active inflammation, thus produced. In one case, four years of continued bad health in an otherwise sound constitution were the penalty inflicted before the real cause was accidentally discovered. During all that time, too, temporary relief invariably followed the use of purgatives, and seemed in some measure to point to the truth; but, from the mind never having been directed to the principles, its practical bearing was overlooked, and now the individual wonders that the cause did not, even at first sight, arrest the attention of his medical advisers.

In cases of this description, however, it ought to be observed, it is not the mere constipation which injures the health and requires to be removed. It is in reality to *the mode of life which induces it* that we ought to direct our attention; for, unless that be amended, all our efforts to preserve the health by merely removing the effect will prove insufficient.

In the natural and healthy state, under a proper system of diet, and with sufficient exercise, the

bowels are relieved regularly once every day. In some constitutions, however, the ordinary period is shorter or longer than this—twice a day, or only once in two days; but such differences are unimportant when they do not proceed from morbid causes, or in any way disturb the health. Habit, in this, as in other operations under the influence of the nervous system, is powerful in modifying the result, and in sustaining healthy action when once fairly established. Hence the obvious advantage of observing as much regularity in relieving the system as in taking our meals, and the impropriety of attempting to break through the habit when once formed. Sleep seems to be favourable to the progress of nutrition, and it is apparently during the night that the assimilation of the daily food is completed, and its residue prepared for being expelled along with the other excretions. Hence there is a natural tendency in the bowels to act in the morning, and we ought therefore to encourage it by a voluntary effort. Even the reception of breakfast into the stomach seems to act as a stimulus to intestinal contraction, and in consequence many persons experience the inclination immediately after their morning repast, and suffer if they are prevented from yielding to it.

Where either from constitutional weakness, sedentary occupation, or other unavoidable causes, the bowels are unable to act sufficiently to relieve the system without assistance, we have, of course, no choice but to select that which is most suitable to the circumstances and most gentle in its operation; because, if assistance be not afforded, the health will assuredly suffer. Numerous examples of this kind are met with every day; and, when treating them, we should always be careful to aid nature as far as possible by an appropriate diet and regimen, and not trust to medicine alone for recti-

fying the consequences of the patient's misconduct. We ought, in short, never to lose sight of the great truth, that, if the bowels were originally constituted by the Creator with power to act sufficiently on the application of their own stimulus, food, there must necessarily be a wide departure from his laws in some part of our conduct to cause the loss of that power; and therefore, whenever we find the bowels unable to act without medicine, our first business ought to be to discover and rectify the error into which we have fallen—and recourse should be had to medicine only in so far as it shall be necessary to remedy the consequences which the transgression has brought upon us.

As the sole object of the present volume is to make the reader acquainted with the *natural* laws of the animal economy, and with the means by which aberrations from them may be prevented and health preserved, I shall not enter at all upon the discussion either of the morbid conditions of the bowels, or of the remedies by which these may be cured; and consequently shall say nothing further of the use of purgative or other medicines. The consideration of these matters is not only foreign to the subject, but would require an extent of detail much beyond my present limits.

Perhaps some persons may think, that, before concluding, I ought to apologize for having introduced to the notice of the general reader such topics as those discussed in this and some of the former chapters. In doing so, I have been actuated by a deep sense of the misery arising from the prevailing ignorance on subjects which, although in themselves as interesting and important as any to which the human mind can be directed, have nevertheless been passed over in silence, partly from not the least suspicion being generally entertained of their real

bearing on our health and happiness, and partly also from false notions of delicacy diverting attention from their calm and deliberate examination. In endeavouring, therefore, to unfold what I conceive to be useful truths, in the language of reason, I confess that I feel no apprehension that any well-constituted mind will receive contamination from the perusal of what is contained in these pages.

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THE END.